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# BITTER PIT IN APPLES.

## SOME RECENT INVESTIGATIONS.*

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Bitter Pit probably dates back at least as early as the initiation of commercial apple-growing. According to McAlpine the earliest recognisable record of the disease was made in Germany in 1869 and in Australia in 1886. The first name given to it was Stippen, which was used in Germany in 1892, but the later name Bitter Pit given to it by Cobb in New South Wales in 1895 is more commonly used in English-speaking countries.

Bitter Pit came into prominence in Australia following the early development of an overseas trade in apples, somewhere about 1900. This trade led to a large increase in the area under apple trees. The presence of the disease in the orchards and especially on the young trees, together with complaints from England of its occurrence in exported fruit, made it apparent that it was not to be lightly regarded. In 1908 at a Conference held in Melbourne of the National Fruitgrowers' Association, a motion was passed asking the Commonwealth Government to undertake an investigation into the cause and control of Bitter Pit. Little assistance in the way of investigations could be looked for from abroad, as in no other country did the trouble appear to cause such severe losses as in Australia. The problem seemed to be essentially an Australian one. This has been confirmed by agents' reports, and more definitely by Dr. Barker who made a detailed inspection of the 1927 shipments in England on behalf of the Empire Marketing Board. It is evident that not only is Bitter Pit more marked in Australian apples than those from elsewhere, but also that it is the principal defect of our apples in European markets. In 1911 the Commonwealth Government appointed

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D. McAlpine, the then Plant Pathologist of Victoria, to carry out investigations for a period of four years. He completed his work in 1916 having in the meanwhile produced five large volumes which form the principal published work on the subject to date. He developed a theory as to the origin of the disease, but like other theories, both earlier and later, it offered nothing which appeared to open a way to place the control of the disease in the hands of growers. Of the principal results of McAlpine's work perhaps the most important was the demonstration that heavy pruning of susceptible varieties increased the liability of the fruit to Bitter Pit, at least in the orchard. This knowledge has become general amongst growers, and varieties like Cleopatra are given a minimum of pruning.

Up till the present time therefore, although a large amount of miscellaneous information has been accumulated in regard to the disease, it has continued unbated both in the orchards and in exported shipments. It has, indeed, come to be regarded by growers as more or less inevitable though varying in its effects from season to season.

In 1926 Dr. A. J. M. Smith, an English Scientist attached to the Low Temperature Research Station at Cambridge, carried out some investigations in Tasmania into the problem. He came to the conclusion that some varieties are specially liable to develop Pit while on the trees and that others tend to develop it more after picking. Further, of the latter varieties, the fruit picked early was more liable than the fruit picked later. Dr. Smith carried out his tests with Ribston and Cox's Orange Pippins.

In 1927 Wickens and Carne had experiments carried out at Bridgetown in Western Australia with Cleopatra apples. From the results of these experiments, taken in conjunction with those of Smith and others in Australia and America, they came to the conclusions that—

(a) Bitter Pit is developed in store as well as on the trees; and

(b) The earlier susceptible varieties are picked the greater their liability to Bitter Pit in store.

Carne then put forward a theory that Bitter Pit is due to the actual picking of the fruit in an immature condition. He considered that it is caused by a loss of water from the fruit as a whole which was finally borne by the more immature cells, resulting in their drying-out and death. This effect on the immature cells results from the irregular manner in which apples ripen, the more mature or sugar-filled cells being in close association with less mature starch-filled cells. As the result of osmotic action the sugar-filled cells draw water from the starch-filled cells. If the loss from the latter is sufficiently great, they are killed.

It was decided to continue the investigations during the 1928 season, and in preparation a study was made of the whole situation with a view of defining the problem to be first attacked. It appeared that the following were fundamental, and it was decided to concentrate on these problems:—

1. Confirmation of the findings of Wickens and Carne that Pit may develop in store as well as in fruit on the trees, and that in store its incidence is related to the maturity of the fruit when picked.

2. Assuming Pit to develop in fruit both on the tree and in store, is the disease in stored fruit identical with that developed in the fruit on the trees? If not, which of the two is Bitter Pit?

3. If Pit developed in stored fruit of susceptible varieties as the result of their method of ripening, is there any difference in the method of ripening of susceptible and non-susceptible varieties?

4. If Pit developed in stored fruit of susceptible varieties to a degree determined by their immaturity when picked, what constitutes a safe maturity for picking and how may it be recognised?

The investigations were carried out by the writer, his assistant Mr. H. G. Elliott, and Mr. H. A. Pitman, B.Sc.Agr., an officer of the Council for Scientific and Industrial Research, whose services were made available for the purpose.

The following is a brief statement of the methods adopted and the results obtained. Full details will be found in a bulletin to be published by the Council for Scientific and Industrial Research.

## Problem 1.

*That Bitter Pit is developed in storage, and that the earlier susceptible varieties are picked the greater their liability to Bitter Pit.*

To test this, picking tests were carried out with the variety Cleopatra at Karagullen, Western Australia. Six pickings from trees with normal crops were made at weekly intervals commencing on the 6th February, six cases being picked each time. The fruit of each picking was graded and then placed part in cold store and part in ordinary store. That in cold store was kept for 10 weeks and then removed to ordinary storage for two weeks, thus allowing sufficient time to cover the longest period fruit is likely to be held from the time it leaves Australia until it reaches the retail buyer. That in ordinary storage was kept six weeks, at the end of which the earlier pickings were no longer commercially saleable. At the end of these periods the fruit was cut up and examined for Bitter Pit. The results of this test, taken in conjunction with those in Tasmania by Smith, in America by Brooks and Fisher using the varieties Jonathan, Grimes, and Gano, and by Overholzer and Fidler using Gravenstein, in Victoria by Adam using Annie Elizabeth, and by Wickens and Carne in Western Australia with Cleopatra, led to the following definite conclusions:—

1. That Bitter Pit is developed in stored fruit.

2. That larger fruits are more susceptible than smaller.

3. The liability to Pit decreases as the fruit becomes more mature at the time of picking.

4. That the quality of the fruit, after storage, becomes better in colour and flavour as its liability to Bitter Pit decreases.

5. That delaying picking too long increases the liability in storage to over-ripeness, especially in large fruit.

Problem 2.

*The identity of the disease developed in fruit on the tree and that developed after storage.*

It has been the practice in Australia to consider all the non-parasitic spot disorders of apples as 'Bitter Pit," although Jonathan Spot has been more or less recognised as a distinct disease.

A study of the literature and of the specimens which became available during the season showed that "Bitter Pit" in the sense used in Australia included disorders not recognised as Bitter Pit in other countries. An intensive study of the external symptoms and of the internal lesions, both macroscopically and microscopically, combined with the study of the symptoms described for Spot diseases elsewhere, led to the conclusion that three distinct diseases differing in origin and usually readily separable by the naked eye had been confused in the past.

It became evident that the bulk of the so-called "Bitter Pit" developed in fruit while on the trees was in reality a form of a disease called Cork in America. The Bitter Pit developed in store was, however, identical with the Stippen of Europe and with the disease originally named Bitter Pit by Cobb. It was obvious that these diseases must be investigated separately. It was also found desirable to subdivide Bitter Pit and Cork into the principal forms in which they are found.

The classification adopted is as under:—

1. *Bitter Pit or Stippen.*—Developed in stored fruit and rarely, if at all, in fruit on the trees. Two forms occur—

(a) Mild Pit, developed in either ordinary or cold storage.

(b) Severe Pit, developed only in cold storage.

2. *Cork.*—Developed only in fruit while on the trees. Four types are recognised—

(a) Blotchy Cork. This is the most common and most serious form found in Australia. This type has also been found in New Zealand, but apparently not in America.

(b) Crinkle Cork, previously known as Crinkle, Confluent Bitter Pit or Pigface.

(c) Internal Cork, the original type of Cork recorded in America. The so-called Bitter Pit of pears in Australia belongs to this type.

(d) Drought Spot Cork, described in America as Superficial Drought Spot. This includes much of what is known as sunburn.

3. *Jonathan Spot.*—Developed mainly after picking. More or less confused with Bitter Pit and Cork by previous writers.

The following descriptions give the more obvious distinctions between the three principal types of these diseases found in Australia:—

*Bitter Pit* (Figs. 1 and 2)—

Externally affected fruits show small spots mainly towards the calyx end. These may vary from grey or yellow to dark brown or almost black—from simply a discoloured spot to a definitely marked more or less circular pit rarely exceeding one-eighth inch in diameter.

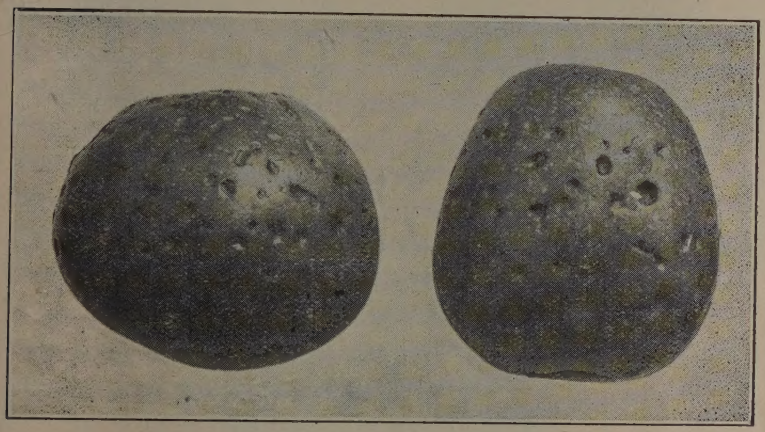

Fig. 1.—Severe Bitter Pit on Dunn's and Cleopatra from cold store.

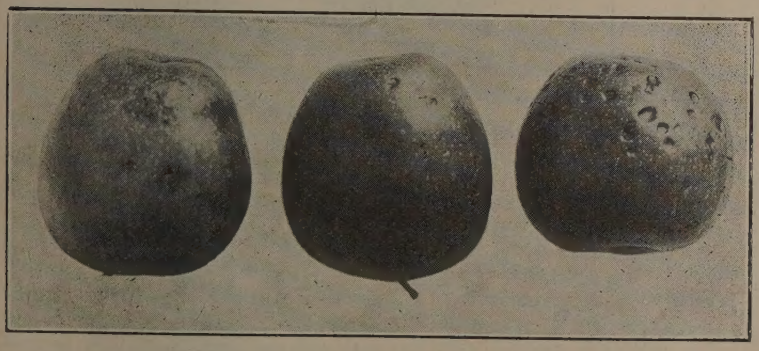

Fig 2.—Blotchy Cork, Mild Pit and Severe Pit on Cleopatra.

In Mild Pit the spots are small and relatively inconspicuous while in Severe Pit they are larger, more deeply pitted and darker in colour. In the flesh of pitted apples dead brown areas are developed, which if associated with the surface spots are not larger than them in diameter.

*Blotchy Cork* (Figs. 2 and 3)—

In typical cases the spots differ from those of Bitter Pit in being much larger and more irregular. The surface of the fruit is distinctly depressed, and the spots are either green or brown or green mottled with brown. The brown spots are smaller in diameter than the dead tissue in the flesh beneath. The masses of dead tissue are typically larger, and are frequently more deep-seated than in Bitter Pit. When apples are affected very slightly with Cork, it is difficult to distinguish the disease from Bitter Pit, but for all general purposes, spots associated with dead tissue in the flesh may be regarded as Cork if formed in apples while on the tree, and Bitter Pit if formed after picking.

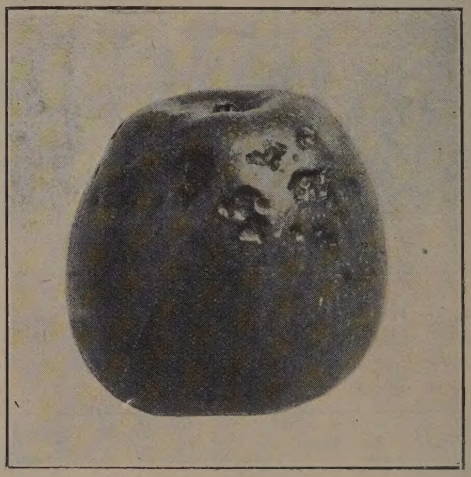

Fig. 3.—Blotchy Cork on Cleopatra.

*Jonathan Spot* (Fig. 4)—

This differs mainly from Pit and Cork in that it develops in the skin of the fruit and rarely penetrates deeply into the flesh. Further, each spot originates around a lenticel (as the numerous small breathing organs easily seen on an apple are called). If the apple is peeled the spots are removed with the peel and the flesh beneath in typical cases is perfectly sound.

Summing up, Blotchy Cork may be recognised by large irregular depressed areas on the surface, varying in colour, but usually consisting of a green halo surrounding dark spots. Bitter Pit has smaller more regular spots never with a green halo, and not necessarily pitted. Jonathan Spot forms spots which may be larger than Bitter Pit, but not as depressed or accompanied by a green halo as in Blotchy Cork, nor do they typically

penetrate the flesh. Where secondary infection by moulds has followed Jonathan Spot, the spots become distinctly rounded with smooth edges and rotting of flesh sets in.

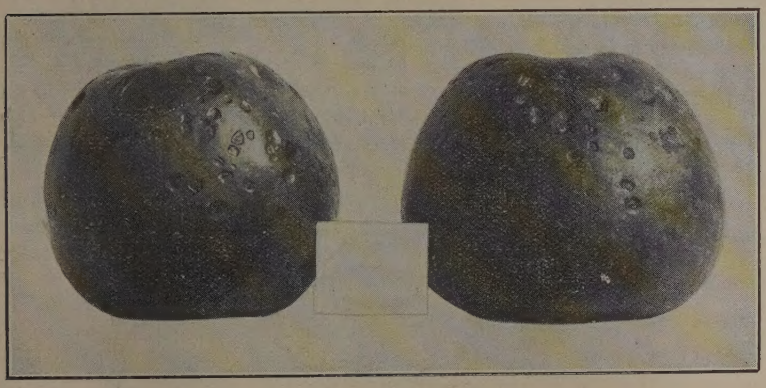

Fig 4.—Jonathan Spot on Spitzenburg. (Note secondary infection by fungi on left-hand fruit.)

## Problem 3.

### *How an apple ripens.*

It was shown by Bigelow, Gore and Howard in 1905 that the process of ripening could be followed by testing apples for starch with iodine at different stages of maturity, provided the tests were made immediately after picking.

Our tests by this method have shown that in general an apple commences to ripen in and around the core and towards the stem end. The last parts to ripen are towards the calyx end near the surface and around the vessels in the flesh, or in other words, the last parts to ripen are those in which Bitter Pit is usually found.

Examination of different varieties showed that outside the core line the starch disappeared more or less irregularly. The effect of the iodine is to turn the flesh containing starch blue or purple, and the presence of starch can be taken as an indication of immaturity. If an apple is cut across its diameter and iodine applied to the cut surfaces, a blue stain will appear as follows (Figs. 5-7):—

(a) In very green apples all the flesh will be blue, or a little unstained flesh may appear around the core.

(b) In ripening but still immature apples the flesh around the core will be unstained, and the remainder will be broken up into bands, wedge-shaped masses or spots of blue tissues separated by unstained areas.

(c) In ripe apples the staining will be confined to small patches or spots near the surface, or if very ripe, no staining will appear at all.

While in general these reactions are the same for all apples, distinctions in the regularity with which the starch disappears can be recognised in different varieties. In Cleopatra, a very Pit-liable variety, the ripening or starch disappearance is very irregular, and the close association of starch-filled cells with those from which the starch has disappeared is normal. In Granny Smith, a moderately Pit-liable variety, the ripening is more regular, but the close association of cells with and without starch occurs. In Yates, a variety never known to be affected by Bitter Pit, the disappearance of starch throughout the flesh is much more regular, and appears to go on to a greater or lesser extent in all the flesh cells at the same time, so that a definite association of stained and unstained tissues does not occur.

These results support the idea that Bitter Pit is associated with the disappearance of starch, and that the susceptibility of a variety is determined by the regularity of starch disappearance from the cells of the flesh. The greater the irregularity the greater the susceptibility to Bitter Pit.

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## Problem 4.

*How to recognise maturity of apples for picking.*

No satisfactory guide to the maturity of apples for picking had been devised up till the present. Recommendations based upon the development of the ground colour, the colour of the pips, and the ease with which the fruits leave their stalks, are generally given. An instrument known as a pressure-tester was devised for the purpose in America, but neither there nor in our tests has it proved satisfactory. Indeed only one test appeared to give satisfactory results, and that was the iodine test (which has the advantage of being based upon definite chemical changes going on in the fruit).

In the picking tests with Cleopatra referred to under Problem 1, typical fruits of each grade at each picking were treated with iodine and photographed. When the final results of storage were obtained in regard to Bitter Pit, colour, and flavour, the results were compared with the pictures of the iodine reaction for the several pickings. It was found that the amount of starch shown by the iodine shortly after the apples were picked, was definitely related to the amount of Bitter Pit, colour and flavour subsequently developed by the apples in storage.

It was concluded that the iodine test renders it possible to predict the condition in which apples will emerge from cold storage. The best results were obtained from fruit which showed only small scattered patches of tissue containing starch when picked.

The experiments were confined to the variety Cleopatra, but it is highly probable that the best stage of maturity for other varieties, which are liable to Pit, will be found to be similar to that of Cleopatra.

*Conclusions drawn from the investigation.*

The principal results of the investigation may be summed up as follows:—

1. Bitter Pit is a disease occurring principally, if not entirely, in apples after picking. It has been recorded in many varieties, but Cox's Orange Pippin, Ribston Pippin, Cleopatra, Sturmer Pippin, Dunns, and Granny Smith appear to be the most affected of our principal export varieties.

2. Cork, especially the form Blotchy Cork, is the disease previously known as "Bitter Pit" developing on apples while on the trees. It has been found in many varieties, but in these experiments more particularly in Cleopatra, Spitzenberg, Five Crown, Sturmer Pippin, Newtown Pippin, and French Crab.

3. Jonathan Spot is a superficial spot disease, and has been noted principally on Jonathan and Spitzenberg, but also occurs on many other varieties, including Yates.

4. The problems of the control of Cork and Jonathan Spot still await solution.

5. Bitter Pit is produced in apples by picking before the fruit is sufficiently matured.

6. The correct picking date for varieties susceptible to Bitter Pit can be ascertained by treating the apples with iodine immediately after picking.

7. Picking apples later in the season for export than has been usual will not only reduce the liability of the fruit to Bitter Pit, but will ensure high quality in flavour and appearance.

*The application of the findings of this investigation to commercial practice.*

1. Avoid over-sized apples for export, as these are more liable to Bitter Pit and Internal Breakdown (over-ripeness) than normal sizes.

2. Apples should be picked on the basis of maturity and not on size. It is suggested that the following procedure be adopted for testing for the maturity of Cleopatra apples for export or storage. This method is probably effective for all other susceptible varieties.

Material required.—Iodine solution and a few shallow vessels. To make the solution, dissolve 1 grm. potassium iodide and 0.25 grms. iodine in 100 c.c. water.

Selection of Fruit.—Select not less than twenty typical samples of the fruit of the size grade to be picked.

Method of testing.—(a) Within one hour of picking cut the apples in half equatorially, that is, through the centre of the cheeks. Care should be taken to prevent the cut halves from getting mixed.

(b) Pour the iodine solution into a sufficient number of vessels. Place the cut surface of one-half of each apple in the solution, and leave for one-half minute. Remove and place with treated surfaces upward. Allow to stand for three to five minutes.

(c) Examine the apples, taking note of the development of a blue or purple colour in the flesh. Group the apples on the following basis.

Over-mature for picking.—No colour or practically no colour in the flesh.

Ready for Picking.—Colour in the flesh in small spots scattered through the pulp outside the core line, but none within the core line. Fig. 5 shows the correct reaction.

Fig. 5.—Iodine test for maturity. Cleopatra apples—correct maturity for picking for export or storage.

Too green for picking.—Colour in relatively large patches in the flesh; or flesh all coloured; or flesh coloured except within core line. Compare Fig. 6.

Fig. 6.—Iodine test for maturity. Cleopatra apples—too immature for picking for export or storage.

3. If less than one-half of the tested apples are ready for picking, the test should be repeated a few days later and picking delayed. When one-half of the sample apples give a satisfactory test, these should have their two halves brought together and then be distributed to the pickers and packers to act as standards of maturity. *Special attention should be paid to the external appearance of these standard fruits, particularly the ground colour of the least coloured parts.* Each picker and packer should be then asked to pick a few apples to standard. These should be cut and tested to check his judgment. Once the standard has been fixed in the mind,

little difficulty should be found by experienced persons in selecting apples of approximately the same degree of maturity. *It is essential to remember that picking must be on the basis of maturity primarily and of size only secondarily.* Apples accidentally or unavoidably picked in a condition not up to the maturity standard should be culled by the packers from fruit to be exported or stored.

4. If the preceding recommendations are adopted, it must be remembered that it is assumed the apples will be cold stored within a few days of picking. If cold storage is delayed too long there is a danger of the fruit becoming over-ripe in store. This particularly applies to varieties like Jonathan which are very subject to Internal Breakdown or over-ripeness.

*Acknowledgments.*—Special acknowledgments for material assistance willingly granted in the course of this investigation are due to Mr. G. W. Wickens, State Superintendent of Horticulture; to Mr. T. Price, Manager Illawarra Orchard Company, Karagullen; and to Dr. E. S. Simpson, Government Analyst.

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# "ROSE CHIEF OF WOLLONGBAR."

## THE VALUE OF "BREEDING."

P. G. Hampshire,

Superintendent of Dairying.

In dairy husbandry the slogan that is becoming generally adopted in Western Australia is "Breed," "Feed," and "Weed." There are some stockmen, however, who still believe that breeding is of little value in comparison with feeding, or in other words, that the breed is the feed the cow receives. The writer has always stressed the value of breeding as the basis of herd improvement. Feeding and weeding are the natural corollary.

"Rose Chief of Wollongbar" at 3½ years.

The value of breeding is remarkably exemplified in a study of the Guernsey sire "Rose Chief of Wollongbar," Registered No. 130, Volume II. of the Guernsey Herd Book of Australia. This bull was bred by the New South Wales Government, and was used for some seven years in their Guernsey stud at Wollongbar. Five years ago the West Australian Government purchased this sire, and placed him at the head of the Guernsey stud at Denmark, and now at the age of 12½ years the animal is still hale and hearty, and possessed of an abundant vitality. That this dairy sire, at an age approaching 13 years, should be still active and up to his work is a tribute to the care and management in his early years. However, an additional factor which, without doubt, greatly influenced the outstanding vitality of the animal is the longevity and productiveness of his dam, "Parson's Red Rose 1st" (imp.), Reg. No. 138, Volume I., who lived to the ripe age of 22½ years.

"Rose Chief of Wollongbar" is a remarkable instance of a dairy sire combining practically every desirable feature. In the first place, this bull is of outstanding breed type, being the Champion Guernsey Bull at the Royal Show, Sydney, twice, and at Perth; also winner in Bull and Progeny Class,

Sydney, three times. In addition he is the sire of champion bulls and cows at Sydney. Sons, grandsons, and daughters have secured "Champion" ribbons on seven occasions. His daughters are of outstanding breed type and productivity, and his sons are also of distinct breed type and are "breeders" of type and production. Those who have studied animal breed will appreciate this all round excellence. Some sires may be noted for their outstanding daughters and others for the excellent calibre of their sons, but rarely do we find both male and female progeny of excellent character. Again, some sires breed type and are weak as regards production; others breed production, and are weak as regards type.

The accompanying tables set out the remarkable value of the daughters of this bull, together with the value of his stud sons as dairy sires.

"Rose Chief of Wollongbar's" sire and dam were imported from England. His dam "Parson's Red Rose 1st" is one of the outstanding animals of the breed, being the dam of excellent stock, as in addition to the bulls "Rose Chief of Wollongbar" and "Success of Wollongbar," she is also the dam of Parson's Red Rose 20th," which, under official test over 365 days, produced 1,302 lbs. butter, and is the second highest production Guernsey cow of the world. "Parson's Red Rose 1st" was over 16 years old when this phenomenally high production daughter was calved. This great "mother" of the breed was a high producer, but was not officially tested until over 14 years old.

An examination of the Herd Books discloses that "Rose Chief of Wollongbar" has 52 registered pure daughters. Of these, 30 have been officially tested, 16 are yet too young to be tested, 3 were sold to owners not testing, 3—unable to trace whereabouts. In addition to the pure-bred daughters, there are a considerable number of grade daughters which, however, have not been officially tested, but from observation are of exceedingly good type and production animals.

This great sire has also in this State 26 sons, 29 grandsons, and 12 great grandsons. The stud sons of this bull are "Judge of Wollongbar," "Bounty of Wollongbar," and "Renown of Wollongbar." These three bulls have distinguished records in the Sydney Royal Show ring.

The tables attached give in detail the yields of the daughters of "Rose Chief of Wollongbar" at the different ages up to 5 years, with the production of their dams at the same ages, together with the butter fat test of both the dams and daughters. A perusal of the tables discloses the marked improvement on an average of the daughters over the dams, also the phenomenal increase shown in the average butter fat test.

Table 2 shows the percentage increase in production of the daughters over that of the dams, together with average increase at the different ages.

Table 3 gives particulars of "Rose Chief of Wollongbar's" stud sons' daughters compared with their dams, together with the average butter fat test of the daughters and dams.

As previously referred to a most striking feature in connection with the breeding qualities of this dairy sire "Rose Chief of Wollongbar" is the fact that all his daughters average .63 per cent. greater in butter fat test, the dams averaging 5.22 per cent., the daughters 5.85 per cent. This is equal to an increase of 12 per cent. in the butter fat test.

Table 1.

ROSE CHIEF'S DAUGHTERS COMPARED WITH THEIR DAMS.

*Yields of Butter Fat. Period, 273 days.*

| | Registered No. | At 2 years. | At 3 years. | At 4 years. | At 5 years. | Butter-fat Test. |
|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | % |
| Hope II. | 647 | 391 | ... | 522 | ... | 5·7 |
| Dam—Hope | 280 | 198 | ... | 324 | 756 | 5·8 |
| Leonie IV. | 667 | 345 | 394 | 365 | ... | 5·3 |
| Dam—Leonie II. | 99 | 218 | ... | ... | ... | 4·9 |
| Desdemona III. | 432 | 261 | 257 | 378 | 456 | 5·8 |
| Dam—Desdemona (Imp.) | 39 | ... | ... | ... | 264 | 4·7 |
| Annetta III. | 589 | 300 | ... | ... | ... | 6·1 |
| Dam—Annetta | 242 | ... | 221 | ... | 294 | 5·3 |
| Godolphin Lass II. | 632 | 246 | 378 | 453 | ... | 6·5 |
| Dam—Godolphin Lass | 454 | ... | ... | ... | ... | ... |
| Desma | 433 | 258 | 239 | ... | ... | 5·7 |
| Dam—Desdemona | 264 | 211 | ... | ... | 426 | 6·0 |
| Parson's Red Rose XIX. | 729 | 227 | ... | 318 | 352 | 5·9 |
| Dam—Parson's Red Rose X. | 344 | ... | ... | 252 | 307 | 5·0 |
| Parson's Red Rose XVII. | 528 | 220 | 239 | ... | 334 | 5·7 |
| Dam—Parson's Red Rose XI. | 345 | 201 | 270 | 319 | 307 | 4·6 |
| Mona III. | 523 | ... | 229 | ... | ... | 5·4 |
| Dam—Desdemona (Imp.) | 39 | ... | ... | ... | 264 | 4·7 |
| Dido IV. | 434 | ... | 216 | 292 | 264 | 5·2 |
| Dam—Dido III. | 266 | 229 | 263 | 309 | 402 | 4·8 |
| Gertrude II. | 1126 | 219 | 392 | ... | 438 | 6·0 |
| Dam—Georgina | 449 | ... | 261 | ... | ... | 5·3 |
| Anna III. | 796 | 264 | 355 | ... | 334 | 6·4 |
| Dam—Anna II. | 417 | 228 | 279 | 279 | 394 | 5·5 |
| Beatrix VII. | 801 | 295 | 239 | 346 | ... | 6·4 |
| Dam—Beatrix IV. | 244 | 156 | ... | ... | 271 | 5·5 |
| Bel Air X. | 803 | 256 | ... | ... | ... | 5·7 |
| Dam—Bel Air III. | 14 | ... | 256 | ... | ... | 5·1 |
| Dido V. | 829 | 264 | ... | 302 | ... | 5·2 |
| Dam—Dido III. | 266 | 229 | 263 | 309 | 402 | 4·8 |
| Miss Clatford VIII. | 916 | 232 | ... | ... | ... | 5·2 |
| Dam—Miss Clatford IV. | 298 | 256 | 200 | 296 | 429 | 5·8 |
| Opal II. | 980 | 361 | 443 | ... | ... | 6·3 |
| Dam—Opal | 338 | 243 | 266 | 269 | 608 | 5·2 |
| Parson's Red Rose XXVII. | 982 | ... | 544 | 558 | ... | 6·7 |
| Dam—Parson's Red Rose V. | 340 | 232 | 243 | ... | 361 | 5·8 |

Table 1—*continued.*

| | Registered No. | At 2 years. | At 3 years. | At 4 years. | At 5 years. | Butterfat Test. |
|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | % |
| Princess III. ... ... | 992 | 194 | ... | ... | ... | 5·8 |
| Dam—Princess II. ... ... ... | 354 | ... | ... | 303 | ... | 5·1 |
| Royal Souvenir 2nd ... | 1002 | 232 | 313 | ... | ... | 6·1 |
| Dam—Royal Souvenir ... ... | 176 | ... | 238 | 180 | 326 | 5·3 |
| Chimes II. ... ... ... | 1117 | 203 | ... | ... | ... | 6·1 |
| Dam—Chimes ... ... ... | 428 | 247 | ... | ... | 407 | 5·0 |
| Honor II. ... ... ... | 1129 | ... | 453 | ... | ... | 5·9 |
| Dam—Honor ... ... ... | 279 | 260 | 305 | 477 | 638 | 5·6 |
| Parson's Red Rose XXXIII. | 1137 | 274 | ... | ... | ... | 6·1 |
| Dam—Parsons' Red Rose V. ... | 340 | 232 | 243 | ... | 361 | 5·8 |
| Parson's Red Rose XXXVI. | 1140 | 264 | ... | ... | ... | 5·6 |
| Dam—Parson's Red Rose XI. ... | 345 | 201 | 270 | 319 | 307 | 4·6 |
| Parson's Red Rose XXXIX. | 1142 | 259 | ... | ... | ... | 5·7 |
| Dam—Parson's Red Rose V. ... | 340 | 232 | 243 | ... | 361 | 5·8 |
| Rose Velvet ... ... ... | 1431 | 218 | ... | ... | ... | 5·7 |
| Dam—Velvet ... ... ... | 774 | ... | 243 | 320 | 407 | 4·5 |
| Trust III. ... ... ... | 1156 | 366 | 420 | ... | ... | 5·6 |
| Dam—Trust II. ... ... | 556 | 190 | 206 | 243 | 318 | 5·2 |
| Red Rose ... ... ... | 1357 | 282 | ... | ... | ... | 6·0 |
| Dam—Parson's Red Rose XXXI. | 985 | 302 | 279 | ... | ... | 5·3 |

Table 2.

PERCENTAGE YIELDS OF BUTTER FAT OVER THAT OF DAMS, AT SAME AGE.

| | At 2 years. | At 3 years. | At 4 years. | At 5 years. | Butter Fat. Gain. | Butter Fat. Loss. |
|---|---|---|---|---|---|---|
| | % | % | % | % | lbs. | lbs. |
| Hope II. | + 98 | ... | + 61 | ... | 391 | ... |
| Leonie IV. | + 58 | ... | ... | ... | 127 | ... |
| †Desdemona III. | ... | ... | ... | + 72 | 192 | ... |
| Annetta III. | + 43 | ... | ... | ... | 129 | ... |
| Desma | + 22 | ... | ... | ... | 47 | ... |
| Parson's Red Rose XIX. | ... | ... | + 28 | + 14 | 111 | ... |
| *Parson's Red Rose XVII. | + 9 | — 9 | ... | + 9 | 15 | ... |
| †Mona III. | ... | + 24 | ... | ... | 65 | ... |
| ‡Dido IV. | ... | — 17 | — 5 | — 34 | ... | —202 |
| Gertrude II. | ... | + 50 | ... | ... | 131 | ... |
| Anna III. | + 16 | + 20 | ... | — 15 | 52 | ... |
| Beatrix VII. | + 95 | ... | ... | + 47 | 264 | ... |
| Bel Air | + 19 | ... | ... | ... | 50 | ... |
| ‡Dido V. | + 15 | ... | — 2 | ... | 28 | ... |
| Miss Clatford VIII. | — 9 | ... | ... | ... | ... | 24 |
| Opal | + 47 | + 66 | ... | ... | 295 | ... |
| §Parson's Red Rose XXVII. | ... | +123 | ... | + 68 | 548 | ... |
| Royal Souvenir 2nd | ... | + 31 | ... | ... | 75 | ... |
| Chimes II. | — 17 | ... | ... | ... | ... | 44 |
| Honor II. | ... | + 48 | ... | ... | 148 | ... |
| §Parson's Red Rose XXXIII. | + 18 | ... | ... | ... | 42 | ... |
| *Parson's Red Rose XXXVI. | + 26 | ... | ... | ... | 63 | ... |
| §Parson's Red Rose XXXIX. | + 11 | ... | ... | ... | 27 | ... |
| Red Rose | — 7 | ... | ... | ... | ... | 20 |
| Trust III. | + 92 | +103 | ... | ... | 390 | ... |
| Rose Velvet | + 10 | ... | ... | ... | 25 | ... |
| Average Increase | 30% | 43·9% | 20% | 23% | 3215 | 290 |
| | | | | | 290 | |
| | | | Total Gain | | 2925 | |

* Sisters. † Sisters. ‡ Sisters. § Sisters. 39 lactations average 75lbs. fat more than their dams.

TABLE 3.

"ROSE CHIEF'S" STUD SONS.—"JUDGE OF WOLLONGBAR'S" DAUGHTERS COMPARED WITH THEIR DAMS.

*Yields of Butter Fat.*

| | Registered Number. | At 2 years. | At 3 years. | At 4 years. | At 5 year | Butter Fat Test. | Butter Fat. | Test. |
|---|---|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | % | lbs. | |
| *Golden Pearl IV ... ... | 863 | 385 | 449 | 351 | ... | 5·8 | | |
| Dam—Golden Pearl III. ... ... | 457 | ... | 240 | ... | ... | 5·1 | +209 | + ·7 |
| Dinah II. ... ... ... | 832 | 365 | 368 | 307 | ... | 5·2 | | |
| Dam—Dinah ... ... ... ... | 435 | 208 | ... | ... | ... | 4·6 | +157 | + ·6 |
| Parson's Red Rose XXVIII. | 983 | ... | 341 | ... | 363 | 5·4 | | |
| Dam—Parson's Red Rose XXII. ... | 732 | 203 | ... | ... | ... | 4·5 | + 88 | + ·9 |
| Princess Vivid II. ... ... | 994 | ... | 209 | ... | ... | 5·6 | | |
| Dam—Princess Vivid ... ... | 538 | 164 | ... | ... | ... | 4·8 | — 5 | + ·8 |
| Dido VIII. ... ... ... | 1122 | 330 | ... | ... | ... | 5·9 | | |
| Dam—Dido III. ... ... ... | 266 | 229 | 263 | 309 | 402 | 4·8 | +101 | +1·1 |
| *Golden Pearl V. ... ... | 1128 | 225 | ... | ... | ... | 5·8 | | |
| Dam—Golden Pearl III. ... ... | 457 | ... | 240 | ... | ... | 5·1 | + 35 | + ·7 |
| Godolphin Lass III. ... | 1127 | 278 | ... | ... | ... | 5·3 | | |
| Dam—Godolphin Lass II. ... ... | 632 | 245 | 378 | ... | ... | 6·1 | + 33 | — ·8 |
| Miss Clatford IX. ... ... | 1132 | 270 | ... | ... | ... | 5·0 | | |
| Dam—Miss Clatford V. ... ... | 520 | 242 | ... | ... | 320 | 5·6 | + 28 | — ·6 |
| Miss Clatford X. ... ... | 1133 | 229 | ... | ... | ... | 5·7 | | |
| Dam—Miss Clatford IV. ... ... | 298 | 254 | 199 | 295 | 429 | 5·7 | — 25 | ... |
| Desdemona V. ... ... | 1119 | 346 | ... | ... | ... | 5·2 | | |
| Dam—Desdemona III. ... ... | 432 | 261 | 257 | 378 | 334 | 5·6 | + 85 | —· 4 |
| Bel Air XIV. ... ... | 1382 | 356 | ... | ... | ... | 5·9 | | |
| Dam—Bel Air VII. ... ... ... | 250 | 210 | ... | 288 | 329 | 4·8 | +146 | +1·1 |

"BOUNTY OF WOLLONGBAR'S" DAUGHTERS COMPARED WITH THEIR DAMS.

*Yields of Butter Fat.*

| | Registered Number. | At 2 years. | At 3 years. | At 4 years. | At 5 years. | Butter Fat Test. | Butter Fat | Test. |
|---|---|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | % | lbs. | |
| Bonnie Pearl IV. ... ... | 1165 | 346 | ... | ... | ... | 5·6 | | |
| Dam—Golden Pearl IV. ... ... | 863 | 385 | 449 | 351 | ... | 5·8 | — 39 | — ·2 |
| Chimes III. ... ... ... | 1118 | 239 | ... | ... | ... | 5·6 | | |
| Dam—Chimes ... ... ... | 428 | 247 | ... | ... | 407 | 5·0 | — 8 | + ·6 |
| Dido IX. ... ... ... | 1123 | 325 | ... | ... | ... | 5·2 | | |
| Dam—Dido IV. ... ... ... | 434 | 178 | 215 | 291 | ... | 5·0 | +147 | + ·2 |
| Modesty II. ... ... ... | 1134 | ... | 162 (Sick) | ... | ... | 5·7 | ... | + ·8 |
| Dam—Modesty ... ... ... | 299 | 203 | ... | 291 | 277 | 4·9 | | |
| Parson's Red Rose 40th ... | 1143 | 347 | ... | ... | ... | 6·1 | | |
| *Dam—Parson's Red Rose 20th ... | 730 | 486 | 574 | ... | 870 | 6·0 | —139 | + ·1 |
| Princess V. ... ... ... | 1148 | 182 | ... | ... | ... | 5·8 | | |
| Dam—Princess III. ... ... ... | 992 | 193 | ... | ... | ... | 5·8 | — 11 | ... |

*Second highest producing Guernsey cow in the world.

"RENOWN OF WOLLONGBAR'S" DAUGHTERS COMPARED WITH THEIR DAMS.

*Yields of Butter Fat.*

| | Registered Number. | At 2 years. | At 3 years. | At 4 years. | At 5 years. | Butter Fat Test. | Butter Fat | Test. |
|---|---|---|---|---|---|---|---|---|
| | | lbs. | lbs. | lbs. | lbs. | % | lbs. | |
| Dessie II. ... ... ... | 1121 | 220 | ... | ... | ... | 5·3 | | |
| Dam—Dessie ... ... ... ... | 612 | 251 | ... | ... | ... | 5·1 | — 31 | + ·2 |
| Parson's Red Rose 34th ... | 1138 | ... | 506 | ... | ... | 5·6 | | |
| *Dam—Parson's Red Rose 20th ... | 730 | 486 | 574 | ... | 870 | 5·8 | — 68 | — ·2 |
| Parson's Red Rose 38th ... | 1141 | 337 | ... | ... | ... | 5·9 | | |
| Dam—Parson's Red Rose 18th ... | 728 | ... | 193 | 230 | ... | 5·2 | +144 | + ·7 |

*Second highest producing Guernsey cow in the world.

Table 4.

ROSE CHIEF'S DAUGHTERS COMPARED WITH DAMS.

| | Butter Fat. Average. lbs. |
|---|---|
| At 2 years—Daughters (16) | 286 |
| Dams (same age) | 223 |
| Increase | 63 |
| | lbs. |
| At 3 years.—Daughters (9) | 375 |
| Dams (same age) | 259 |
| Increase | 116 |
| | lbs. |
| At 4 years.—Daughters (5) | 398 |
| Dams (same age) | 311 |
| Increase | 87 |
| | lbs. |
| At 5 years.—Daughters (5) | 348 |
| Dams (same age) | 334 |
| Increase | 14 |

ALL AGES.

| | lbs. |
|---|---|
| Daughters (35) (74% under 3 years) | 334 |
| Dams (same ages) | 260 |
| Average Increase | 74 |

All tests 9 months period.

BUTTER FAT TEST.

| | | |
|---|---|---|
| All Daughters (average) | 5·85% | |
| All Dams (average) | 5·22% | |
| Increase | ·63% | equal to 12% |

It will be noted, after perusal of the above tables, that they contain the records of production of all the daughters of "Rose Chief of Wollongbar" and do not, as is sometimes the case, show only the high producing daughters. It is without doubt the only satisfactory way to compare a sire's breeding value to obtain an average of all daughters as compared with their dams (at same age), and not the results of certain high-producing daughters.

"Rose Chief of Wollongbar" at 12½ years.

In assessing the breeding value of this sire, it should be taken into consideration that the production records of the dams of "Rose Chief's" daughters were made some few years earlier than those of the daughters, and probably methods of feeding and management have improved to a certain extent which would account for some portion of the increased yield shown by the daughters. There is, however, one outstanding feature which feeding and management cannot influence, namely, that of the increased test shown by the daughters over their mothers. The average test of the mothers is higher than the average of the Guernsey breed, so that the influence of this sire in regard to butter fat test improvement is the more remarkable.

# PHOSPHATIC LICKS FOR STOCK.

Geo. L. Sutton,
Director of Agriculture.

Investigations carried out during comparatively recent years have shown how much more important, than was formerly considered to be the case, is an adequate supply of the mineral constituents such as Phosphorus, Calcium, Sodium, Potassium, Iron and Iodine in our stock foods. Though the amount of these in the food is relatively so small as to appear almost insignificant, the benefits to be derived from remedying any deficiencies, when they exist, are outstanding, and, in consequence, increasing attention is being given to the use of "stock licks" as being the best means of supplying the mineral constituents in which pastures may be lacking. Whatever may be the case regarding the lack of other mineral constituents, there is reason to believe that the natural pastures in the agricultural areas of Western Australia are deficient in phosphorus.

In the first volume of this "Journal"* attention was drawn to the phosphorus deficiency which evidently exists in the natural pastures of the South-West agricultural areas. It was then pointed out that certain troubles and diseases such as "Cripples" ("Styfsiekte" in South Africa), and Paralysis Impactum (Dry Bible), were directly or indirectly due to phosphorus deficiency in the pastures, and could be remedied by supplying phosphates in the food, or as "stock licks."

Further evidence as to the deficiency of phosphorus in our pastures is furnished indirectly by the remarkable response which our crops make to the application of soluble phosphatic fertilisers, *e.g.*, Superphosphate. This shows that the phosphorus content of our agricultural soils is low, and obviously such a condition will be reflected in the low phosphorus condition of our pastures. Support to this view is obtained from the information contained in an unpublished thesis by Eric J. Underwood, B.Sc. Ag., written as part of his work in connection with the "Amy Saw Scholarship." This thesis is based upon the result of a study of 26 pastures obtained from widely differing and widely separated portions of the central agricultural areas. The pastures were inspected and samples collected for analyses during Mid-Spring when the herbage was about half mature. Those obtained north of Perth in the Gingin, Geraldton and Northampton area were classed as Northern, and the others as Southern. Each of these sections was then divided into "Good" or "Poor," according to the reputation which each had from the stockman's point of view. The "good" pastures carry more stock and show better conditions of growth and fattening than the "poor."

In connection with the Southern group the author found that "the fibre and the lime contents are in general much higher, and the protein and phosphatic acid contents decidedly lower than the corresponding pastures of Great Britain," and further, "it is significant that even these "good" Western Australian pastures are lower in phosphoric acid and total protein than the poor Scotch hill pasture." In connection with the "poor" Southern pastures it is stated, "The figures for phosphoric acid are particularly low, and approach very closely to the figures given by Theiler and his co-workers as those at which chronic osteophagia develop in veldt cattle. Moreover, these

* Adams, A. B.—W.A. Jnl. of Agr., June, 1924.

workers have shown that the amount of phosphorus just required to prevent osteophagia is well below the optimum requirements for the cattle. The lack of phosphorus is, therefore, likely to be a limiting factor in growth, reproduction, milk yield, and fattening in stock grazed upon them.

With regard to the "good" Northern pastures the conclusions arrived at are—"When compared with the English and Scotch pastures it is seen that the "good" Northern pastures contain quite high percentages of lime, total ash and silica free ash, and fairly large amounts of protein. The figures for phosphoric acid are also nearer those given for the British pastures than in any of the Southern samples analysed." The conclusions connected with the "poor" pastures are—"In comparison with the British pastures these samples show quite a high proportion of lime, total ash and silica-free ash. The fibre content is also high, but the total protein very low indeed. The phosphoric acid percentages are each lower than are the average English and Scotch pastures, and with the exception of A5, previously mentioned, lower than the poor Scotch hill pastures."

Although the scope of the investigation on which the thesis was based was necessarily limited, it provides grounds for assuming that the stock on some of the reputed "good" pastures would, even in Spring, be better for the addition of supplementary phosphorus in some form, and that on the "poor" pastures the phosphorus content is so low—in some cases dangerously low—as to point to the absolute need for such an addition to the pasture.

The classical investigations of Sir Arnold Theiler and his co-workers in connection with a South African disease called "Lamsiekte,"* provide information from which additional evidence regarding the phosphorus deficiency of our pastures can be obtained. The investigators found that the direct cause of this disease was a toxin causing a ptomaine poisoning, but due indirectly to phosphorus deficiency in the pasture. This phosphorus deficiency led to a depraved appetite, in consequence of which the animals in mild cases chewed bones, or, in more advanced ones, ate carcase debris and so swallowed the toxin, which brought about the ptomaine poisoning. The trouble was remedied by feeding phosphates in the form of bonemeal. This removed the phosphorus deficiency, and, in consequence, the desire to chew bones or eat rubbish disappeared; there was then no toxin ingested, and no ptomaine poisoning. In this case the depraved appetite, as shown by the craving which the cattle had for bones and decomposing carcases, was the indicator or outward sign of the phosphorous deficiency in the pastures.

The depraved appetite due to a deficiency of phosphorus in the diet may exhibit itself in many ways. The animals may have a desire for excessive amounts of salt or for chewing bones, in which latter case it is known as "Osteophagia." In extreme cases it take the form of a craving for all sorts of rubbish, and the animal will then chew leather, rags, and even show a desire to lick tins and stones; it is then known as "Allotriophagia."

The South African investigators point out that "Osteophagia," or bone chewing, "is the most obvious outward sign, or clinical symptom, of phosphorus deficiency in cattle; and although not infallible, is a very valuable indicator of such deficiency in the majority of veldt-bred bovines. Curiously enough it is not shown to the same extent by other animals; is, for instance, only feebly manifested by sheep."

* Theiler, Sir A.: "The Cause and Prevention of Lamsiekte"—Jnl. Agr. Union of Sth. Africa, June, 1920.

Seeing that the depraved appetite of bone chewing ("Osteophagia") is only feebly manifested by sheep, a case where sheep had passed beyond this stage and developed a craving for carcase debris ("Allotriophagia") furnishes evidence of extreme phosphorus deficiency in the pastures. Such an instance was reported from a district in the Wheat Belt during the past summer. In this case the carcases were those of poisoned rabbits, and a very general impression which prevailed in the district was that the mortality was due to the eating of the poison which had killed the rabbits. Following upon a request to the Veterinary Branch for advice and assistance, Mr. H. W. Bennetts, Veterinary Pathologist, definitely diagnosed the cases as those of "Botulism." He found that the mortality was not due to the rabbit poison, but that, like "Lamsiekte," in South Africa, it was directly the result of the ingestion of toxin, which the sheep obtained from the carcases as the result of infection with a bacterium, and indirectly due to a phosphorus deficiency in the pasture. The remedy prescribed was to destroy the carcases and improve the phosphorus deficiency of the pasture by the addition of another food or stock lick rich in phosphates. A bonemeal lick was recommended so that, by supplementing the diet with phosphorus, the deficiency would be removed, the unnatural craving for the rabbit carcases would disappear, the sheep would not ingest the toxin, and the mortality would cease.

Though the destruction of the carcases would have prevented a recurrence of the disease by preventing the sheep from obtaining the toxin produced by the saprophytic bacterium, which is the direct cause of the mortality, this treatment, though essential on hygienic grounds, is incomplete in that it does not remove the indirect cause of the trouble, viz., the phosphorus deficiency, hence the need for supplementing the food of the pasture with some compound of phosphorus as well as for the destruction of the carcases.

During the South African investigations into the phosphorus deficiency of pastures,* it was found that the phosphorus content was not uniform throughout the year. The investigators point out—"The following analyses of mixed grasses cut from the Armoedsvlakte veldt at different times of the year are of interest. A considerable proportion of the total vegetation consists of bushes and of plants rarely eaten by stock, but since the main food of the grazing cattle is derived from the grasses, only the analyses of these need be considered:—

| Date. | Crude protein. | Ether extract. | N-free Extractives. | Crude Fibre. | Ash.* | $P_2O_5$. | CaO.* | Estimated energy value Starch = 100. | Ratio of starch equivalent to $P_2O_5$. |
|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | | |
| 10 November, 1919 ... | 19·4 | 5·5 | 41·0 | 22·5 | 11·6 | ·60 | ·81 | 56 | 100 : 1·07 |
| 8th December, 1919 ... | 14·3 | 5·6 | 46·8 | 25·6 | 7·7 | ·32 | ·59 | ... | ... |
| 15th January, 1920 ... | 13·8 | 5·5 | 48·0 | 25·0 | 7·7 | ·22 | ·50 | 52 | 100 : 0·42 |
| 4th March, 1920 ... | 7·2 | 3·4 | 49·8 | 33·7 | 5·9 | ·24 | ·43 | ... | ... |
| 19th April, 1920 ... | 4·9 | 2·4 | 51·6 | 35·0 | 6·1 | ·11 | ·46 | 32 | 100 : 0·33 |
| 11th May, 1920 ... | 4·1 | 2·2 | 52·9 | 34·9 | 5·9 | ·07 | ·50 | ... | ... |
| 8th June, 1920 ... | 4·0 | 2·0 | 53·7 | 33·1 | 7·2 | ·09 | ·59 | 25 | 100 : 0·36 |
| | | Euro | pean fi | gures f | or com | parison | | | |
| Rich pasture grass ... | 20·5 | 4·6 | 45·9 | 19·0 | 10·0 | ·7 | ·9 | 60 | 100 : 1·16 |
| Poor meadow hay ... | 8·7 | 1·7 | 44·8 | 39·0 | 5·8 | ·4 | ·9 | 22 | 100 : 1·81 |

*Figures for Ash and CaO variable owing to contamination with dolomitic dust.

* Theiler, Green & Du Toit: "Phosphorus in the Livestock Industry"—Sth. African Dept. Agr. Jnl., May, 1924.

"The data are expressed upon the dry matter of the plant, *i.e.*, after removing the moisture in a warm oven, in order to simplify comparison of feeding value and of phosphorus content. The very young green grass of early spring (October to November) it will be noted, is highly nutritious and has a fairly high phosphorus content, but after the seed has fallen (April to May) the general feeding value, or "energy value," is reduced to less than half, and then approximates that of a poor European hay. The most striking feature, however, is the extraordinary low phosphorus content, averaging about .08 per cent. phosphorus oxide ($P_2O_5$), or only one-fifth of that present in ordinary European hays. As the grass matures, carbohydrate formation in the plant proceeds so much faster than phosphorus absorption from the soil that the percentage of phosphoric oxide rapidly falls."

There is a considerable amount of similarity between the grazing conditions in South Africa and Western Australia. In both countries the pastures are alternately succulent and dry. In South Africa the flush or succulent period is in the spring and early summer, say, October to January, whilst in Western Australia the succulent period is in winter and early spring, say, May or June to September or October. Because of this similarity in the grazing conditions between the two countries, it is probable that the information obtained in South Africa, regarding the changes which take place in the mineral content of the pastures, would apply also to West Australian pastures. It is reasonable, therefore, to infer that our pastures as they become dry and lose their seeds become deficient in phosphorus, though when young, green and succulent the reverse may have been the case.

The tremendous importance of making good the phosphorus, if any, of our pastures is brought out by the South African investigations. Subsequent to the initial investigations in connection with "Lamsiekte," Sir Arnold Theiler and his co-workers found that phosphorus deficiency, in addition to being the indirect cause of disease and death, also had a very material and restrictive effect upon the growth and production of the animals they were dealing with, *i.e.*, veldt-grazed cattle. They found that the addition of phosphate to the natural pasture poor in phosphorus enabled young animals to make much better growth, and to use the food available to a much better advantage. In referring to the better growth obtained as the result of supplementing the pasture with phosphates in the form of bonemeal, they state: "Expressed as percentage increase on initial live-weight, the gains are naturally most striking with young animals. The chart shows that calves of 300 lbs. live-weight that have increased in weight to about 470 lbs. during the season on the natural grazing, and to about 640 lbs. when supplied with bonemeal." It will thus be seen that the increase in weight was doubled as the result of supplementing the natural pasture with a phosphate. Their conclusion regarding the more economical use of the food when the phosphorus deficiency was made good is: "It is quite clearly shown that although animals receiving a bonemeal ration do eat more food in putting on additional weight, they also give a much better return 'per unit of food consumed.' When the phosphorus deficient controls were coaxed to eat more food than required for mere maintenance, they simply 'combusted' the excess for no useful purpose. A functional, as well as a structural role, is predicted for phosphorus in cellular metabolism,

and an analogy drawn with the 'vitamins.' The practical effect of this is that the stock-carrying capacity of the pasture is increased as the result of making good the phosphorus deficiency."

Even with the low milk-producing veldt cattle grazed on phosphorus deficient pastures it was found that the milk yield responded favourably to the addition of phosphate in the form of bonemeal, and that the batch receiving bonemeal averaged about 40 per cent. more milk. As the investigators point out, "Low phosphorus is, therefore, a limiting factor in milk production," and "With dairy stock the differences would unquestionably be much more striking."

More recent work by the same investigators* has shown that a phorporus deficient diet also restricts the rate of increase; of the control cows on a deficient phosphorus diet 51 per cent. calved; of the cows receiving a ration of bonemeal to make up the phosphorus deficiency, 80 per cent. calved normally, thus showing that the "calf crop" is increased as the result of making up the phosphorus deficiency. These later investigations† also show that when exposed daily to bright sunshine "Vitamine deficiency of the diets had no adverse effect. Exogenous requirements of cattle for vitamines A, B and C are so low that they are covered by a few pounds of poor quality roughage (*e.g.*, wheat straw), and therefore do not enter into consideration under any natural system of cattle rearing." The South African investigations were carried out with cattle, but there is no room for doubt that the evils consequent upon a phosphorus deficient diet would apply with equal force to sheep and other animals, as would also the benefits to be derived from supplementing such a diet with phosphorus in some form or other.

Though there is no direct evidence in this connection, it is reasonable to expect that phosphorus additions to a deficient diet would also have a beneficial effect upon the quality and quantity of wool produced. In this connection Sir Arthur Theiler, in his address on "Stock Diseases and their Prevention," stated: "I wish to mention that this (viz., phosphorus deficiency) has probably also some relation to the production of wool. Cattle which I experimented with and which were properly fed with a balanced mineral ration showed remarkable change in the skin, and a remarkable change in the gloss of the hair. So that it was quite evident that the covering of the animal was affected also, and affected to the advantage of the animal itself. I do not see why what took place in the cattle should not take place in another way, and which can be controlled in sheep.

Concisely stated the advantages of supplementing a phosphorus deficient diet with phosphatic stock licks, or in other ways are—

(a) Mortality and diseases directly and indirectly due to a phosphorus deficiency in the diet are prevented;

(b) Young animals are enabled to make maximum growth;

(c) Young and older animals are enabled to make the most economical use of the food available:

* Theiler, Green & Du Toit—Jnl. Agric. Science, July, 1928.
† Theiler, Green & Du Toit—Jnl. Agr. Science, July, 1927.

(d) Milk production is increased:

(e) Wool production is probably improved, and

(f) The rate of natural increase is raised.

It is believed that there is now abundant evidence to show—

(a) That in our agricultural areas, except in the very best pastures, there is a deficiency of phosphates in the natural feed, and particularly when the feed is dry;

(b) That in view of the South African investigations there is an urgent need to remedy the deficiencies, and

(c) That it is extremely profitable to do so.

In connection with (a) it seems advisable to conclude that all *dry* pastures, and particularly cereal stubbles, unless they contain an abundance of clover seeds or other leguminous grains, are likely to be deficient in phosphorus, and, in consequence, need to be supplemented with "phosphatic stock licks" or other foods rich in some phosphorus compound.

It seems probable also that heavy producing milch cows, even when feeding on clover pasture, particularly if dry, will require to have it supplemented with some food rich in phosphorus like bran or bonemeal, for during the investigations already referred to in connection with the prevention of "Lamsiekte" it was found, curiously enough, that the feeding of lucerne hay (*i.e.*, hay similar to clover hay) was not as effective as either bran or bonemeal, though the phosphorus content of the lucerne hay was just as high as that in the bran or bonemeal.

The phosphorus deficiency in our pastures can be remedied mainly in two ways—

(a) By top-dressing with suitable phosphatic fertilisers, and

(b) By supplementing the pasture with phosphatic licks or other food containing phosphates.

Where the land is valuable enough to warrant it, as in agricultural areas, both methods should be adopted, and in such cases the use of phosphatic "stock licks" will then be confined to the months when the feed is dry, except probably in the case of high producing milking cows. In some cases, as for instance, where the land is of low carrying capacity owing to arid conditions, top-dressing with phosphatic fertilisers may not be an economical way of remedying the phosphorus deficiency in the pastures, it is then necessary to make up the deficiency by means of "phosphatic stock licks."

From the results of the South African investigations* apparently any phosphorus compound will prove efficient as a "stock lick" provided it is assimilable and convertible into the form of phosphate," and further, that "calcium phosphate can take the place of bonemeal, and this compound is quantitatively superior to bonemeal if fed as precipitated calcium phosphate, but inferior if fed as ground mineral phosphate. Not only the

* Theiler, Sir Arnold: "The Cause and Prevention of Lamsiekte."—Jnl. Dept. Agr., Sth. Africa, June, 1920.

quantity of phosphate must be taken into consideration, but also its availability.....Whatever substance is fed it seems that the common factor of phosphorus must always be present. The behaviour with pure phosphoric acid indicates that the base in combination is unimportant, except in so far as it affects the absorption and utilisation of the compound itself. The compromise between "cheapness" of compound and "efficiency per unit of phosphoric acid" has not yet been worked out.

Some years later it was stated that the best and cheapest method of supplementing the phosphorus deficient diet of grazing cattle under South African conditions was by no means of bonemeal. It was also found that bran was excellent but expensive—"The phosphorus contained in bran and in bonemeal can be treated as about equally available in digestion, and the two sources therefore evaluated on the basis of their phosphorus content; 1 oz. of bonemeal being as useful in rectifying phosphorus deficiency as about 1 lb. of average South African wheaten bran." Owing to the high cost of bran "per unit of phosphorus" it only comes into consideration in practice when a definite value is placed upon it as an ordinary supplementary feed in a mixed ration, *e.g.,* for dairy cows."

The same conclusions regarding the advisability and economy of feeding bran to remedy phosphorus deficiencies will also apply in Western Australia but not with regard to bonemeal. For feeding to stock the bonemeal requires to be sterilised in order to prevent the spread of infectious stock diseases, and on that account it is expensive costing £21 per ton in the Metropolitan area. When compared with the price of mineral phosphates its cost in this State is relatively greater than in South Africa. Its use, therefore, does not provide the necessary compromise between "cheapness" and "efficacy per unit of phosphoric acid." It is believed that this will be supplied in the future by a specially prepared and comparatively cheap precipitated calcium phosphate. In the meantime, however, two calcium phosphates are on the market, the cost of which is less than 1/3rd that of sterilized bonemeal. These are recommended pending the time when either a precipitated calcium phosphate or a cheaper bonemeal will be available. The two calcium phosphates referred to are Basic Superphosphate and finely ground Rock Phosphate. In both the relative proportion of Phosphorus to Lime is the same as in bonemeal. Basic Superphosphate has the advantage that it contains precipitated calcium phosphate, but its disadvantage is that it also contains about 50 per cent. of Gypsum, which as far as is known serves no useful purpose and must be regarded as an adulterant. Rock Phosphate has the advantage that it contains a greater percentage of phosphorus, but in the South African experiments it proved less effective per unit of phosphorus than bonemeal. How much less effective with cattle and sheep is not known, but in some experiments with pigs* it was found that Rock Phosphate was about 25 per cent. less efficient than specially prepared bone flour.

Either compound my be used separately, but with the object on the one hand of reducing the amount of adulterant in the Basic Superphosphate, and on the other of improving the efficiency of the Rock phosphate a mixture of the two in equal proportions may be adopted, as is the case in at least one proprietary "stock lick." Both compounds are likely to be

* Utilisation of Calcium Compounds in Animal Nutrition."—Bull. 347 Ohio Expt. Stn., March, 1921.

unpalatable to sheep and cattle, and as the likes and dislikes of animals are matters of importance when licks are fed separately from the ration, it will be necessary to mix them with something to increase their palatability. Molasses is likely to prove useful in this connection, as is also salt, and in many cases this latter will also prove a useful addition.

So that the proportion of salt may not be unduly large, and thus prevent the animals from obtaining from the lick all the phosphorus they need, it is suggested that salt be added in proportions of one part for every two of the phosphate, and that to this be added about 12 per cent. of molasses. The approximate proportions of such a lick would be :—Basic Superphosphate or Ground Rock Phosphate, 10 parts; Salt, 5 parts; Molasses, 2 parts; and to make 1 cwt. the amounts would be:—

SUGGESTED PHOSPHATIC STOCK LICKS.

| Materials. | | A. | B. | C. |
|---|---|---|---|---|
| | | lbs. | lbs. | lbs. |
| Basic Superphosphate ... ... | 10 parts | 66 | ... | ... |
| *or* | | | | |
| Ground and Rock Phosphate ... | „ | ... | 66 | ... |
| *or* | | | | |
| Basic Superphosphate and Ground Rock Phosphate | 5 parts | ... | ... | 33 |
| | | ... | ... | 33 |
| Salt ... ... ... ... | „ | 33 | 33 | 33 |
| Molasses ... ... ... ... | 2 parts | 13 | 13 | 13 |
| | | 112 | 112 | 112 |

Should the stock at first not take readily to the mixture the addition of a little more molasses may help matters, or even more salt may be added until the animals become accustomed to the lick, when the salt may be gradually reduced to the original quantity.

Superphosphate will also remedy phosphorus deficiency; its use, however, is not recommended as the South African experience indicates that it is likely to lead to digestive troubles.

Superphosphate can be made into Basic Superphosphate by mixing it with quick lime freshly slaked to a powder, or with air-slaked lime, the former being preferred. The amount of lime necessary for the purpose depends upon its degree of purity. Assuming 80 per cent. purity the approximate proportions would be—Superphosphate 4½ parts and quick lime 1 part. If air slaked lime is used the proportions would be superphosphate 2½ parts and air slaked lime 1 part. The mixing of superphosphate and lime is not recommended, it is better to purchase the basic superphosphate already prepared.

Stock need a "lick" most when the feed is dry, and when they are carrying or rearing calves or lambs; they need it least when the feed is green, but even in this latter case a "phosphatic stock lick" can do no harm, and is likely to be of benefit. The amount of phosphorus to be supplied in the form of a "lick," if the animals are on pasture, or as a supplement to the food if they are hand fed, depends upon the extent of the deficiency in the pasture or feed and upon the character of the animals. As pointed out by Sir Arnold Theiler and his co-workers, "The demands for phosphorus are least for mere maintenance, intermediate for growth, and highest for milk production." For the conditions under which investigations were conducted

the amounts recommended were ½ lb. of bonemeal, or its equivalent, per head per week for adult bullocks and young calves, ¾ lb. for growing stock over 300 lbs. in weight, or up to 2 lbs. or even more for milking cows. The ration is preferably given in the form of daily portions, or at least tri-weekly; bi-weekly or weekly portions are wasteful and ineffective. For milking cows and hand fed animals the ration is best given mixed with the feed.

Even in good pastures, if desired, a simple "phosphatic stock lick" can be left with the stock throughout the year. No fear need be felt that the animals will obtain too much, or an injurious quantity of, phosphorus. An amount of calcium phosphate in excess of their normal requirements will not hurt them; and if they do consume more than is needed to make up the deficiency in the pasture, such excess will be returned to the soil in the excreta, and have the same effect as top-dressing the pastures with a phosphatic fertiliser.

Because of the great importance of remedying phosphorus deficiency in the pastures of the agricultural areas, and the fact that the deficiency can be remedied by some form of calcium phosphate, it is probable that mineral phosphates, either untreated or treated, will have the same beneficial effect upon the well being of our stock as they, in the form of superphosphate, have had upon the productivity of our wheat fields and pastures.

It is important to emphasise that the fundamental reason for using stock licks is to make up deficiencies that are known to exist in the food. In as far as they serve this purpose they are useful and advisable, but in most cases they are wasteful and may even be harmful if they supply materials which are not lacking. It is, therefore, not advisable to use, without veterinary advice, licks which contain ingredients which are not known to be required to make up deficiencies in the diet. At present there is no definite information to indicate that generally there is any deficiency in our pastures other than that of phosphorus, and, in consequence, the only known need at present is for a straight "phosphatic stock lick."

# SOIL ALKALI.

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## I.—ITS NATURE AND OCCURRENCE.

In view of the importance of "alkali" on many farms in Western Australia, a series of articles is being prepared to state the underlying principles connected with "salt" accumulation and to indicate what measures may be adopted to mitigate the evil. Most of the studies on "alkali" in other parts of the world have been in connection with irrigation practice, and the results and recommendations are often not applicable to Western Australian conditions owing to a lack of water for leaching purposes. The alkali problems of Western Australia must be tackled from another standpoint—that of the dry-farm farmer—and the measures adopted will be conditioned by—

1. The value of the land.
2. The use to which the land is suited.
3. The topographical and climatic features of the area.
4. The nature of the soil affected.

*Definition.*—The term "alkali" is somewhat loosely applied, but most authorities agree in the following definitions:—

*Alkali* refers to soluble materials which exist in the soil in excessive amounts.

(a) *White Alkali* consists of one or more of such salts as sodium chloride (common salt), sodium sulphate (Glauber's salts), sodium nitrate (Chili saltpetre), magnesium sulphate (Epsom salts), magnesium chloride, calcium chloride, and perhaps others under exceptional conditions.

(b) *Black Alkali* consists of sodium carbonate, commonly known as washing soda or sal soda.

In Table 1 and Table 2 are given figures showing the composition of the alkali salts in soils in the United States and other parts of the world.

TABLE 1.—PERCENTAGE COMPOSITION OF ALKALI SALTS IN SOILS

(Lyon, Fippin and Buckman "Soils," 1916, p. 393.)

| | | Colorado Expt. Station. | California (Tulare) Exp. Sta. | Yakima, Washington, 12–24in. | Billings, Montana. | | Yuma, Arizona. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Crust. | Surface 10in. | Crust. | 0-72in. |
| White Alkali— | | | | | | | | |
| Potassium chloride | KCl | 1·64 | ... | 5·61 | ... | ... | 4·00 | 22·10 |
| Potassium sulphate | $K_2SO_4$ | ... | 3·95 | ... | 1·60 | 21·41 | ... | ... |
| Sodium sulphate | $Na_2SO_4$ | ... | 25·28 | ... | 85·57 | 35·12 | ... | ... |
| Sodium nitrate | $NaNO_3$ | 33·07 | 19·78 | ... | ... | ... | ... | ... |
| Sodium chloride | NaCl | 6·61 | 14·75 | ... | 0·55 | ... | 81·15 | 13·77 |
| Sodium phosphate | $Na_2HPO_4$ | ... | 2·25 | ... | ... | ... | ... | ... |
| Magnesium sulphate | $MgSO_4$ | ... | ... | ... | 8·90 | 4·06 | ... | 6·88 |
| Magnesium chloride | $MgCl_2$ | 12·71 | ... | ... | ... | ... | 7·71 | 3·98 |
| Calcium chloride | $CaCl_2$ | 17·29 | ... | ... | ... | ... | 0·25 | ... |
| Sodium bicarbonate | $NaHCO_3$ | ... | ... | 36·72 | 0·67 | 22·06 | 0·28 | 21·02 |
| Calcium sulphate | $CaSO_4$ | 21·48 | ... | 1·87 | 2·71 | 10·07 | 6·61 | 32·25 |
| Calcium bicarbonate | $Ca(HCO_3)_2$ | ... | ... | 16·48 | ... | ... | ... | ... |
| Magnesium bicarbonate | $Mg(HCO_3)_2$ | ... | ... | 15·73 | ... | ... | ... | ... |
| Ammonium carbonate | $(NH_4)_2CO_3$ | ... | 1·41 | ... | ... | ... | ... | ... |
| Black Alkali— | | | | | | | | |
| Sodium carbonate | $Na_2CO_3$ | ... | 32·58 | 13·86 | ... | 7·28 | ... | ... |
| Potassium carbonate | $K_2CO_3$ | ... | ... | 9·73 | ... | ... | ... | ... |

TABLE 2.—COMPOSITION OF THE SOLUBLE ALKALI IN VARIOUS COUNTRIES.

(From Bulletin 35, Bureau of Soils, 1906. "Alkali" Soils of the United States, by C. W. Dorsey, page 35.)

| | White Alkali. | | | | | | Black Alkali. |
|---|---|---|---|---|---|---|---|
| | Potassium sulphate ($K_2SO_4$). | Sodium sulphate ($Na_2SO_4$). | Sodium chloride (NaCl). | Sodium phosphate ($Na_2PO_4$). | Magnesium sulphate ($MgSO_4$). | Magnesium chloride ($MgCl_2$). | Sodium carbonate ($Na_2CO_3$). |
| EUROPE— | per cent. | per cent. | per cent. | per cent. | per cent. | per cent. | per cent. |
| Hungarian Plain— | | | | | | | |
| Kalocsa | ... | 0·2 | 51·7 | ... | ... | ... | 48·1 |
| Debreczin | ... | 1·6 | 4·4 | 1·5 | ... | ... | 92·5 |
| ASIA— | | | | | | | |
| Plain of the Araxes | ... | 10·4 | 74·6 | ... | ... | ... | 14·7 |
| | ... | 18·2 | 69·7 | ... | ... | ... | 12·1 |
| | ... | 15·5 | 15·5 | ... | ... | ... | 69·0 |
| Aden | ... | ... | 32·8 | ... | ... | ... | 67·2 |
| India | 11·1 | 7·0 | 2·9 | ... | ... | ... | 79·0 |
| AFRICA— | | | | | | | |
| Egypt | ... | 23·6 | 48·2 | ... | ... | ... | 28·2 |
| | ... | 38·3 | 14·0 | ... | ... | ... | 47·7 |
| Fezzan | ... | ·6 | ·7 | ... | ... | ... | 98·7 |
| AUSTRALIA— | | | | | | | |
| Bendigo | 1·28 | 40·05 | 47·47 | ... | 11·20 | ... | ... |
| | 1·63 | ... | 81·88 | ... | 9·86 | 6·73 | ... |

White alkali is harmful on account of its effect on the plant and on the soil; its presence makes it difficult or impossible for the plant to absorb water from the soil, and, if in sufficient quantities, will kill the delicate cells of the rootlets. In addition a chemical reaction takes place between the clay of the soil and sodium of the alkali. Unless there is an adequate amount of calcium present this reaction goes so far that the normal calcium clay turns to a sodium clay which is gelatinous and very harmful to plants as well as being impossible for proper cultivation.

Black alkali is formed from this gelatinous clay by the action of water and carbonic acid. Water acts on the clay, forming small amounts of sodium hydroxide (the ordinary lye used in making soap). By the action of carbonic acid dissolved in the soil water the sodium hydroxide is changed to sodium carbonate or black alkali. Thus black alkali, the most harmful of all common forms of alkali, may be formed from white alkali if the soil is poorly supplied with soluble calcium.

*Origin of Alkali.*—All forms of alkali are derived from rock weathering, and, being soluble, tend to be washed to lower levels with water movement. Accumulation occurs in inland seas, lakes and, principally, in the ocean. There is also a movement of soluble salts in the air where they exist as very fine dust derived from sea spray, and from the surfaces of saline accumulations such as alkali spots and salt lakes. The air borne salts are washed down by rains and accumulate in the soil. There is a possibility of this wind-carried material being responsible for the salinity of soils in certain areas of the world. In other areas, the alkali is definitely residual, resulting from the evaporation of inland bodies of water due to a change in the climate of the region.

*Occurrence of Alkali.*—Practically all countries receiving a low annual rainfall have an alkali problem to a greater or lesser degree. Contributions to the subject come from the Central European countries, Africa and America in particular. In the future Australia will add to the literature on soil alkali because the greater part of the area of Australia receives a rainfall under 20 inches per annum, under which conditions there is a decided tendency for soluble materials to accumulate in the soil. This is because the loss by drainage is less than the gain due to soil and rock weathering plus additions by the avenue of the atmosphere. The soluble materials normally accumulate in the soil in a layer at a distance below the surface depending on the annual rainfall and the permeability of the soil.

The results of analyses of alkali-affected soils in various parts of the world are reported in Table 3. These figures bring out the effect of the texture of the soil as well as the annual rainfall.

TABLE 3.—DEPTH OF ACCUMULATION OF SOLUBLE SALTS (ALKALI) IN SOILS.

| Locailty. | Rainfall. | Depth. | Soil texture. |
|---|---|---|---|
| Fresno, California ... ... ... | 8in. | 3 to 4 feet | Sandy loam. |
| Do. ... ... ... | „ | 4 „ 8 „ | Coarse sand. |
| Imperial Valley, California ... ... | 3in. | 15in. | Sandy loam. |
| Ventura Co., California ... ... | 15in. | 5 feet | Sandy loam. |
| Grand Forks, North Dakota ... | 20in. | 3 „ | ? |
| Gezira, Egypt ... ... ... ... | 15in. | 3 to 5 „ | Heavy clay. |

This applies to clay and calcium carbonate as well as to alkali. It is well known that the subsoil (technically known as the B. horizon of the soil) is generally more clayey in character than is the surface soil. Also, the subsoil in districts of low rainfall will generally effervesce strongly with dilute acid (spirits of salt mixed with several volumes of pure water), while the surface soil gives no reaction. The calcium of the surface layers of the soil is thus leached out by the rains and deposited in the subsoil. This deposit of calcium carbonate, clay and alkali indicates at least two things. First, that the average rains do not saturate the soil below a certain depth. Second, that the normal tendency is for the soluble materials to move *downwards* with the moisture.

Through the ages the water absorbed by the soil either evaporates through the medium of the vegetation and through surface evaporation, or seeps away to feed the lakes, rivers and swamps, carrying with it soluble material dissolved from the soil. The extent of this latter process is well exemplified by the salt lakes which intersect Western Australia and South Australia. When it is remembered that these accumulations have taken place during the period in which the country has been covered with forest, it will be predicted that areas of these "lakes" will increase following the destruction of the natural vegetation, leading to an increase in salt accumulations in the lakes and other drainage areas.

The alkali problem is most acute in countries where the seepage is further augmented by irrigation. Irrigation without adequate drainage invariably leads to a rise in the water table, which is a danger signal. With a water table within three to six feet of the surface, the difficulty of obtaining an adequate soil mulch is extremely great, and the alkali is brought to the surface by the capillary processes of the soil. On evaporation of the water at the surface of the soil the saline material remains in the surface layers and may accumulate to the extent of as high as six per cent. of the mass of the soil. The alkali problem is acute in certain localised areas in places enjoying a rainfall of 20 to 30 inches per annum. Clearing the timber leads to a rise of the water table in the creeks and the formation of more or less permanent springs and damp areas at places where an impervious layer comes to the surface. In areas of lower rainfall, moisture movement, and with it the movement of soluble materials, is limited and slow so that it is probable that the condition will never be so acute in its incidence in these districts. It will, however, be of much more general occurrence for the reasons given above.

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## II.—THE TOLERANCE OF PLANTS FOR ALKALI IN SOILS.

Some classes of soil are infertile on account of the absence of an adequate supply of soluble materials This will apply to certain sandy soils in Western Australia. Alkali soils are infertile on account of the excessive concentration of soluble salts in the soil solution. Most farmers in Western Australia are familiar with the occurrence of "salt" patches—often ascribed to "magnesia."

Plate I. shows a typical alkali spot in a field of oats in the State of Utah, United States of America.

Small alkali spot remaining in a field reclaimed by irrigation in the Sevier Valley, Utah. Before reclamation no cultivated crop could be grown.

United States Department of Agriculture, Bulletin 34, 1906.

It has been estimated that nearly one million acres of irrigable land, amounting to ten per cent. of the total area under irrigation in the United States, has been ruined by the occurrence of alkali. The State of California, which depends largely on irrigation water for its farm and orchard supply, has had to face a very severe alkali problem, and its investigators have been studying the question during the last 35 years.

A summary of the results obtained by Loughridge (Bulletin 133, California Experiment Station, 1901) is published by C. W. Dorsey in Bulletin 35, Bureau of Soils, U.S. Department of Agriculture, 1906, pages 41 and 42, and is reproduced in this article for the guidance of those interested:—

Table 4.

Highest quantity of alkali salts to a depth of 4 feet by which fruit trees and various crops were found unaffected—arranged from the highest to the lowest.

*Fruit Trees.*

| Sulphates (Glauber's salt)— | lbs. | Carbonate (sal soda)— | lbs. |
|---|---|---|---|
| Grapes | 48,800 | Grapes | 7,500 |
| Olives | 30,640 | Oranges | 3,840 |
| Figs | 24,480 | Olives | 2,880 |
| Almonds | 22,720 | Pears | 1,760 |
| Oranges | 18,600 | Almonds | 1,440 |
| Pears | 17,800 | Prunes | 1,360 |
| Apples | 14,240 | Figs | 1,120 |
| Peaches | 9,600 | Peaches | 680 |
| Prunes | 9,240 | Apples | 640 |
| Apricots | 8,640 | Apricots | 480 |
| Lemons | 4,480 | Lemons | 480 |
| Mulberry | 3,360 | Mulberry | 160 |

| Chloride (common salt)— | | Total alkali— | |
|---|---|---|---|
| Grapes | 9,640 | Grapes | 45,760 |
| Olives | 6,640 | Olives | 40,160 |
| Oranges | 3,360 | Almonds | 26,560 |
| Almonds | 2,400 | Figs | 26,400 |
| Mulberry | 2,240 | Oranges | 21,840 |
| Pears | 1,360 | Pears | 20,920 |
| Apples | 1,240 | Apples | 16,120 |
| Prunes | 1,200 | Prunes | 11,800 |
| Peaches | 1,000 | Peaches | 11,280 |
| Apricots | 960 | Apricots | 10,080 |
| Lemons | 800 | Lemons | 5,760 |
| Figs | 800 | Mulberry | 5,760 |

TABLE 5.

Highest quantity of alkali salts to a depth of 4 feet by which fruit trees and various crops were found unaffected—arranged from the highest to the lowest.

*Small Cultures.*

| Sulphates (Glauber's salt)— | lbs. |
|---|---|
| Saltbush | 125,640 |
| Alfalfa (old) | 102,480 |
| Alfalfa (young) | 11,120 |
| Hairy vetch | 63,720 |
| Sorghum | 61,840 |
| Sugar beet | 52,640 |
| Sunflower | 52,640 |
| Radish | 51,880 |
| Artichoke | 38,720 |
| Carrot | 24,880 |
| Gluten wheat | 20,960 |
| Wheat | 15,120 |
| Barley | 12,020 |
| Goat's rue | 10,880 |
| Rye | 9,800 |
| Caniagre | 9,160 |
| Ray grass | 6,920 |
| Modiola | 6,800 |
| Bur clover | 5,700 |
| Lupin | 5,440 |
| White melilot | 4,920 |
| Celery | 4,080 |

| Carbonate (sal soda)— | lbs. |
|---|---|
| Saltbush | 18,560 |
| Barley | 12,170 |
| Bur clover | 11,300 |
| Sorghum | 9,840 |
| Radish | 8,720 |
| Modiola | 4,760 |
| Sugar beet | 4,000 |
| Gluten wheat | 3,000 |
| Artichoke | 2,760 |
| Lupin | 2,720 |
| Hairy vetch | 2,480 |
| Alfalfa | 2,360 |
| Grasses | 2,300 |
| Kafir corn | 1,800 |
| Sweet corn | 1,800 |
| Sunflower | 1,760 |
| Wheat | 1,480 |
| Carrot | 1,240 |
| Rye | 960 |
| Goat's rue | 760 |
| White melilot | 480 |
| Caniagre | 120 |

| Chloride (common salt)— | |
|---|---|
| Madiola | 40,860 |
| Saltbush | 12,520 |
| Sorghum | 9,680 |
| Celery | 9,600 |
| Alfalfa (old) | 5,760 |
| Alfalfa (young) | 760 |
| Sunflower | 5,440 |
| Sugar beet | 5,440 |
| Barley | 5,100 |
| Hairy vetch | 3,160 |
| Lupin | 3,040 |
| Carrot | 2,360 |
| Radish | 2,240 |
| Rye | 1,720 |
| Artichoke | 1,480 |
| Gluten wheat | 1,480 |
| Wheat | 1,160 |
| Grasses | 1,000 |
| White melilot | 440 |
| Goat's rue | 160 |
| Caniagre | 80 |

| Total alkali— | |
|---|---|
| Saltbush | 156,720 |
| Alfalfa (old) | 110,320 |
| Alfalfa (young) | 13,120 |
| Sorghum | 81,360 |
| Hairy vetch | 69,360 |
| Radish | 62,840 |
| Sunflower | 59,840 |
| Sugar beet | 59,840 |
| Modiola | 52,420 |
| Artichoke | 42,960 |
| Carrot | 28,480 |
| Barley | 25,520 |
| Gluten wheat | 24,320 |
| Wheat | 17,280 |
| Bur clover | 17,000 |
| Celery | 13,680 |
| Rye | 12,480 |
| Goat's rue | 11,800 |
| Lupin | 11,200 |
| Caniagre | 9,360 |
| Ray grass | 6,920 |
| White melilot | 5,840 |

The results are expressed in pounds per acre in 4 feet depth. In order to calculate these to a percentage basis it must be remembered that an acre foot of soil weighs about 3½ to 4 million pounds. These tables provide a considerable amount of detail concerning the tolerance of various plants of agricultural importance for alkali. For general use, however, the table suggested by the United States Department of Agriculture is of greater value because it is very concise and based on a great deal of experience.

Table 6.

Grades adopted by the U.S. Department of Agriculture with regard to alkali soils.

| Grade. | Total Salt per cent. | Crop behaviour. |
|---|---|---|
| 1 | Up to 0·2 per cent. | All uninjured. |
| 2 | 0·2 „ 0·4 „ | Sensitive plants injured. |
| 3 | 0·4 „ 0·6 „ | Ordinary crops injured. Some pasture plants, sugar beets, barley and sorghum grow. |
| 4 | 0·6 „ 1·0 „ | Date palms and atriplex. |
| 5 | 1·0 „ 3·0 „ | No crops grow. |
| 6 | Over 3·0 „ | No crops grow. |

It is suggested that the soil be sampled to a depth of six feet and the average of the salt contents of the successive layers of one foot be taken as representative of the soil.

Experience has shown that the crop plants may be grouped as follows:—

1. *Sensitive plants*—maize, wheat, young lucerne, burr clover, lupins, peach, orange, prunes, etc.
2. *Resistant plants*—oats, barley, Kafir corn, sorghum, beet, grapes, olives, etc.
3. *Very resistant crops*—Saltbush (*Atriplex spp.*), date palms, couch grass, etc.

Certain plants are recognised as being indicative of salt-bearing soil. Thus saltbush is very generally associated with soils containing excessive amounts of salt according to observations made in America as well as in Australia. No infallible guide is known, however, as there are numerous cases on record of plants, regarded as salt indicators, growing on soils unaffected by alkali. Land carrying saltbush in areas known to be *liable* to "salt" would always be regarded with suspicion pending actual analysis of representative samples.

*Factors in Salt Tolerance.*—The actual amount of "salt" which any crop will tolerate is conditioned by a number of factors.

If there is an abundant supply of water in the soil much more alkali may be present without causing any injury. Thus the Arabs are able to grow sensitive plants in the oases by using a very liberal and frequent application of water, although the water used is quite saline.

Quite closely associated with the supply of water is the atmospheric factor. Under conditions of high evaporation plants will be likely to be more damaged by alkali than when cool and moist conditions prevail.

Another factor is that of soil drainage. The Arabs find it safe to use quite saline water on the sandy soils of the oases because the drainage is perfect and there is no chance for the soluble matter to increase. With slow or poor drainage conditions the results would be disastrous.

Soil texture is a very important consideration and must be viewed from two aspects, viz., the effect of added alkali and the effect of alkali already present.

Sandy soils, on account of their free drainage and low content of clay will be less injured by water containing considerable amounts of soluble salts than will clay soils. On the other hand a sandy soil can safely carry less alkali than a clay soil. The sandy soils hold much less water than do clay soils—probably half as much. This means that at the optimum moisture condition the soil solution, the solution with which the plant roots are bathed, is just twice as concentrated in the sandy as in the clay soil. It is thus clear why a smaller percentage is injurious in a sandy soil.

The percentage composition of the alkali present is very important. Magnesium salts are very injurious. Sodium carbonate is quite injurious on account of its corrosive effect on the plant roots, causing them to turn black. 0.1 per cent. sodium carbonate is suggested as the maximum for cereals. Common salt or sodium chloride is somewhat less toxic, the limit for cereals being about 0.25 per cent. Most plants can withstand about twice as much sodium sulphate (Glauber's salts) as sodium chloride. Hilgard suggests that cereals will tolerate as much as 0.45 per cent. sodium sulphate.

*The Effect of Alkali on Plants.*—It is well known that alkali in large amounts will prevent the germination of seeds. Very often the seeds sown on land affected with alkali will germinate, but the young seedlings are killed by the high conceneration of the soil solution. As a rule, older plants are much more resistant than seedlings. Perhaps the roots have penetrated beyond the zone of alkali accumulation and the delicate root hairs thus escape the effects.

Plants absorb water mainly through the roots. It enters the root cells by a process known as osmosis whereby the water passes from a dilute solution to a concentrated solution. If it happens that the soil solution is *more* concentrated than the root sap the water will tend to pass *from* the root *to* the soil.

The result of this will be the death of the root cells and later the death of the plant.

It has been observed that when grown in saline soils wheat, oats and barley plants appear a bluish green. This is probably due to the waxy coating or cuticle on the leaves which is about one and a half times as thick as on plants grown under normal conditions.

In certain experiments undertaken by the writer (data unpublished) it was found that high concentrations of common salt in the solutions in which wheat plants were grown, caused a decided increase in the rate of respiration of the plants. This may be a factor contributing to the bad effects of alkali on plants.

Not only do different types of plants differ in their tolerance of alkali but individuals of the same variety differ greatly in this respect. In experiments with alkali soils it is almost invariably noticed that a few plants stand out from the rest. Attempts have been made to use the seed from these plants for the production of alkali resistant varieties but with no success up to the present.

*Alkali Tolerance and Adaptation.*—In an interesting article (Univ. of Arizona, Agricultural Experiment Station, Technical Bulletin No. 11, 1926), J. F. Breazeale argues that the alkali tolerance of plants is a matter of adaptation. Throughout the ages types of plants become adapted to the conditions of their environment. Thus saltbush has become adapted to conditions of low rainfall and high salinity. The marine algae (seaweeds) flourish best in seawater. Wheat grows best in soils containing relatively

small amounts of soluble salts. The salts commonly present in alkali soils arrange themselves in approximately the following order of *decreasing* toxicity:—

1. Magnesium sulphate.
2. Magnesium chloride.
3. Sodium carbonate.
4. Sodium bicarbonate.
5. Sodium chloride.
6. Sodium sulphate.
7. Calcium sulphate.

The occurrence of alkali salts in soils correlates quite closely with this order.

Whatever has been the cause of development of differences between plants in their response to the environment, it is the duty of the investigator to determine, if possible, the present characteristics which enable them to survive and flourish. It has been found that couch grass is able to withstand large quantities of black alkali. The researches of Mr. Benjamin of Hawkesbury College in New South Wales indicate that this is due to the presence of a substance known as suberin in the roots. It is suggested that the suberin protects the more delicate constituents of the tissues from decomposition by the powerful chemical in black alkali soils.

Plants adapted to conditions of high salinity usually exhibit a mechanism to lower the rate of transpiration or loss of water through the leaves. Everyone is familiar with the thick, grey leaves of plants growing in salty patches. Workers in the desert laboratories of the Carnegie Institute at Tucson, Arizona, have found that some plants of arid regions possess a substance which limits evaporation of water. This substance may be extracted from the leaves and is just as effective in hindering evaporation from cubes of gelatine as from leaves. Extension of researches along these lines, no doubt will lead to discoveries valuable from both the scientific and practical point of view.

*Treatment of Alkali Soils.*—Where abundant irrigation water is available and the land is valuable, soils affected with alkali may be reclaimed by treatment with such amendments as gypsum, sulphur or sulphur and lime and ferrous sulphate, and then thorough leaching. At the same time provision must be made for adequate and permanent drainage. Where irrigation is not possible the cultivation of alkali resistant crops may be attempted. One of the salt bushes, *Atriplex semibaccata*, has proved valuable in California, Arizona and New Mexico. It may be used for pasturage or cut for hay, and is reported to yield several tons of hay per acre under suitable conditions.

Sorghum may be grown successfully where the land remains fairly moist during the warmer months.

Small patches have been improved by scraping the surface few inches of soil. In any case steps must be taken to cope with a high water table, which is usually the trouble. Under some conditions drains about four feet deep should be constructed in order to carry off the surplus water, and with it the excess of soluble matter.

(*To be continued.*)

# HORTICULTURAL NOTES.

Geo. W. Wickens,
Superintendent of Horticulture.

## SEASONAL WORK FOR JANUARY, FEBRUARY AND MARCH.

### *January.*

Fruit harvesting is the main occupation of fruit-growers at this time of the year, and to a great extent the quality and quantity of the product will be governed by the thoroughness with which the routine work of the past winter and early spring has been performed. Pruning, spraying, fertilising, ploughing, cultivating, hoeing, thinning of surplus fruits must all have received due attention at the proper time if the resultant crop is to achieve that degree of perfection which should be the standard aimed at by every genuine orchardist. The time has gone when haphazard methods were good enough: competition is now keen, and there is a steady increase in the quantity produced with a corresponding accentuation of the marketing problem. But it is noticeable and noteworthy that a glut of really prime fruit hardly ever occurs in this State, and when it does it lasts only for a very short period. Anyone, however, who visits the wholesale markets cannot fail to be impressed with the fact that at a great majority of the sales there is always too large a proportion of low grade stuff. This does not refer to very inferior fruit, which should not be cased up and offered for sale, but to second, third and fourth rate lines which, in many instances, could have been made into a first if the trees and soil had received the required treatment. However, if the attention needed has not been given, and the fruit now ready for marketing is not of the quality it should, and could be, growers so situated may enhance its attractiveness by careful selection, grading and packing. If all the fruit in a case is as nearly as possible of one size and quality, much better prices will be obtained than where the best and worst, and large and small, are placed all together in what may be described as the "jumble pack."

Apart from harvesting operations, soil cultivation and pest control are the main duties now requiring attention.

Every precaution should be taken by all growers in districts infested with fruit fly to keep the pest under control. All fallen fruit should be gathered up, not once or twice a week, but once in every 24 hours, and all fruits found to be infected should be boiled. If this is regularly done ,and foliage baiting and trapping also systematically attended to, losses from this pest can be kept down to small proportions. If no precautions are taken the effect is disastrous, both to the grower concerned and also to his neighbours.

Opportunity is again taken in these notes to remind apple and pear growers that Codlin Moth was present last season in two districts in the State—Collie and Narrogin—and though excellent results were obtained in the war waged against it, the fact must be borne in mind that just as it gained entrance there so it may to any other fruit-growing portion of

the State, and every grower should carefully note any suspicious tunnellings in his fruits, and notify the Department at once. Its presence in fallen apples or pears will be easily detected this month, and it is only by the whole-hearted co-operation of growers and officers of the Department, such as has obtained in past outbreaks, that the pest can be subdued.

The apple crop this season promises to be a heavy one. If sufficient cases for holding same have not been ordered, growers should immediately arrange for further supplies.

*February.*

Gathering and marketing stone fruits and the early varieties of apples and pears, soil cultivation, and measures necessary for the control of insect pests are the major items claiming orchardists' attention during this month.

Some pears and grapes will probably be exported before the end of the month, but immature apples must on no account be sent forward for shipment.

This month and next are the worst periods of the year for Fruit Fly, and constant attention is needed to keep the pest under control.

*March.*

More fruit is exported from Western Australia this month than during any other month of the year, and with a heavy crop of apples a record may be established this season. Every care should be taken by all exporters so that the good name for quality and appearance which "the apples in the red boxes" have gained in the United Kingdom and European markets may be fully sustained. To attain this, every grower should grade uniformly, reject drastically, pack honestly, and stencil or label neatly and correctly.

In pest control give Fruit Fly neither rest nor peace, and closely watch for traces of Codlin Moth.

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The Librarian of the University of Western Australia is anxious to obtain Nos. 10, 11 and 12 of Volume 18, 1909, of the "Journal of Agriculture" in order that their set may be completed.

It is probable that one of the readers of this "Journal," who is in possession of the numbers mentioned, may no longer require them and, if so, the Librarian at the University will be very pleased to receive the copies as a donation.

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# DAIRY FARM COMPETITION IN HARVEY DISTRICT, 1928.

G. K. BARON-HAY, B.Sc. (Agric.),
Assistant Superintendent of Dairying.

The Harvey Agricultural Society is to be congratulated on its move in opening a section in the Show Schedule for the best kept Dairy Farm, which action was made possible by the generosity of Messrs. C. L. Clarke, Burekup, and J. Lowe, Harvey, who made liberal donations for first and second prizes respectively.

Such competitions have been in existence for some years in other parts of the State, and have been productive not only of keen and friendly rivalry between resident farmers, but have been the means of making public the systems of farming being practised by the leading settlers in those districts, and which are best calculated to give the most remunerative returns.

The following conditions were laid down by the Agricultural Society, and accepted by the donors of the prizes, for the guidance of the judge, who was required to visit competitors during October for the purpose of judging their properties, without previous notice having been given.

1. All members of the Harvey Agricultural Society shall be eligible to compete, and that for the first year the competition be limited to members.

2. Points to be awarded as follows:—

| | Maximum. |
|---|---|
| Farm Stock (preference being given to dairy stock of the Zone type) | 50 |
| Pastures ... ... ... ... ... ... ... | 40 |
| Supplementary Fodder Crops ... ... ... ... | 30 |
| Conservation of Fodder ... ... ... ... ... | 30 |
| Farm Buildings, Fencing and general layout ... ... | 35 |
| Farm Implements and Dairy Utensils ... ... ... | 15 |
| Total ... ... ... ... | 200 |

3. With the view of permitting a farmer who has been but a short time on his property to compete with one who has been established many years, points to be added on the following basis:—

| | | | | | |
|---|---|---|---|---|---|
| 3 years from virgin country | —add | 28 | per cent. | of | marks. |
| 4 „ „ „ | add | 24 | „ | | „ |
| 5 „ „ „ | add | 20 | „ | | „ |
| 6 „ „ „ | add | 16 | „ | | „ |
| 7 „ „ „ | add | 12 | „ | | „ |
| 8 „ „ „ | add | 8 | „ | | „ |
| 9 „ „ „ | add | 4 | „ | | „ |
| 10 years or over —Nil. | | | | | |

Prizes: First £10, donated by C. L. Clarke, Esq., Burekup. Second £5, donated by J. Lowe, Esq., Harvey. Third £2.

No less than eleven entries were received, which was most creditable for the initial effort, and the farms were situated in an area from Cookernup in the North to six miles West of Brunswick in the South, a distance of approximately 25 miles.

It was inevitable that over such a large area of the South-West, where farms are relatively small, and which embraces an irrigation area, that many different systems of farming should be encountered, depending primarily on the character of the land and the available water supply for the growth of summer fodder.

There were two main types of farms:—

(a) Irrigable,

(b) Non-irrigable.

Three farms were situated in the Harvey Irrigation Area, while two other competitors had private irrigating schemes.

Crop of peas grown by Mr. R. A. Clifton, Brunswick. More use might be made of this crop. Valuable for fodder or for grain.

These two widely different classes of farms necessitated the exercise of considerable discretion in judging, especially when dealing with the sections headed Pasture, Supplementary Fodder Crops, and Conservation of Fodder.

The guiding principle when dealing with these sections was to determine whether the dairy farmer produced enough suitable fodder on the farm for the maintenance of the *cattle in milk* during the year, whether this fodder be in the form of irrigated pasture, conserved hay, silage, etc.

The following is the list of dairy farmers who entered for the competition, and in Table 1 will be found the points gained by each competitor in the various sections:—

| | Area of Farm. acres. |
|---|---|
| Mr. Stanley Bowers, "Westham," Brunswick ... | 200 (Non-irrigable) |
| Mr. R. A, Clifton, " Innesfree," Brunswick ... | 300 (17 acres irrigable) |
| Mr. A. S. Warburton, " Dalkeith," Brunswick ... | 179 (Non-irrigable) |
| Mrs. C. Settor, " Hainault," Wokalup ... ... | 129 ( do. ) |
| Mr. W. E. White, Wokalup ... ... ... | 167 ( do. ) |
| Miss C. T. Heppingstone, " Rannock," Harvey | 30 (Irrigable) |
| Mr. L. Prince, " Roma," Harvey ... ... | 60 ( do. ) |
| Mr. J. Allen, " Naranjal," Harvey ... ... | 20 ( do. ) |
| Mr. A. E. Rodway, " Eden," Cookernup ... | 78 (Non-Irrigable) |
| Mrs. C. M. Corker, " Woodside," Cookernup ... | 100 ( do. ) |
| Mr. G. H. Clifton, " Woorrarra," Cookernup ... | 80 (Portion irrigable) |

TABLE 1.

| | Stock. 50. | Pastures. 40. | Supplementary Fodder Crops. 30. | Conservation of Fodder. 30. | Buildings, Fences, Lay-out. 35. | Implements Dairy Utensils. 15. | Total Points. 200. | Add Handicap Points. | Final corrected Totals. |
|---|---|---|---|---|---|---|---|---|---|
| Miss L. C. Heppingstone, Harvey | 46 | 40 | 57 (Irrigable) | | 33 | 15 | 191 | ... | 191 |
| Mrs. C. Settor Wokalup | 48 | 37 | 25 | 30 | 32 | 15 | 187 | ... | 187 |
| Mr. W. E. White Wokalup | 46 | 40 | 20 | 30 | 27 | 14 | 177 | 7·08 | 184·08 |
| Mr. G. H. Clifton Cookernup | 45 | 33 | 26 | 27 (Part Irrigated) | 25 | 13 | 169 | 13·52 | 182·52 |
| Mr. R. A. Clifton Brunswick | 45 | 34 | 28 | 28 (Part Irrigated) | 20 | 11 | 166 | 13·28 | 179·28 |
| Mr. S. Bowers, Brunswick | 43 | 35 | 30 | 25 | 20 | 11 | 164 | 13·12 | 177·12 |
| Mr. A. S. Warburton Brunswick | 40 | 36 | 30 | 26 | 15 | 10 | 157 | 18·84 | 175·84 |
| Mrs. C. M. Corker. Cookernup | 44 | 35 | 30 | 26 | 19 | 11 | 165 | ... | 165 |
| Mr. L. Prince, Harvey | 42 | 37 | 53 (Irrigable) | | 20 | 10 | 162 | .... | 162 |
| Mr. A. E. Rodway Cookernup | 25 | 33 | 30 | 25 | 20 | 10 | 143 | 17·16 | 160·16 |
| Mr. J. Allen Harvey | 35 | 35 | 50 (Irrigable) | | 25 | 11 | 156 | ... | 156 |

## DAIRY STOCK.

With one exception the whole of the herds of milch cattle inspected were in first class condition, and were receiving little, and in most cases no hand-feeding at milking times.

This alone is an indication of the rapid strides made in pasture production in these districts, and is in marked contrast to conditions which were commonly encountered as recently as four years ago.

The average yields of the herds were remarkably good, especially those of the three placed farms and those of Mr. S. Bower's herd, as is shown in Table 2.

TABLE 2.

| Name. | Cows in milk. | Total cows excluding 2 year old Heifers. | Total Milk Production. | Average Milk Yield per cow. | Remarks. |
|---|---|---|---|---|---|
| | | | Galls. per day. | Galls. | |
| Miss Heppingstone ... | 20 | 26 | 70 | 3·5 | Pasture only. |
| Mrs. C. Settor ... | 16 | 19 | 49 | 3·1 | Little chaff. |
| W. E. White ... | 17 | 20 | 64 | 3·7 | Pasture only. |
| G. H. Clifton ... | 9 | 15 | 18 | 2·0 | Calves in summer. |
| R. A. Clifton ... | 16 | 16 | 36 | 2·25 | Pasture only. |
| S. Bowers ... ... | 24 | 26 | 70 | 2·9 | do. do. |
| A. S. Warburton ... | 25 | 26 | 61 | 2·4 | do. do. |
| Mrs. C. M. Corker ... | 24 | 28 | 48 | 2·0 | do. do. |
| L. Prince ... ... | 16 | 21 | 36 | 2·25 | do. do. |
| J. Allen ... ... | 5 | 6 | 14 | 2·8 | do. do. |
| Averages ... ... | 17·2 | 20·3 | 46·6 | 2·69 | |

Table 2 gives some idea of what may be expected from a herd of 17 cows fed on good pasture only, and where the milk is separated on the farm, the butter fat being sent to a factory and the skim milk fed to pigs or calves.

With butter fat valued at 1s. 8d. per lb. and skim milk valued at 2d. per gallon, an average herd comprised of 17 cows similar to the above, with milk testing only 4 per cent. butter fat, would return £53 5s. 6d. per month from the sale of butter fat and skim milk. The nett profit of course would depend to a great extent on the cost of producing feed for the stock, the cheapest of which is undoubtedly pasture.

## "ZONE" BREEDING.

The Harvey Agricultural Society has loyally supported the policy of the Superintendent of Dairying (Mr. P. G. Hampshire) for the "Zone" breeding of dairy cattle, and the wisdom of this policy is now being realised by the society, whose annual show is already regarded as the leading show for milking Shorthorn cattle outside the Perth Royal Show, in which zone Harvey lies.

It was most gratifying to find that this policy is apparently being adhered to by farmers also, as practically all the competitors were either grading up now with pure bred bulls of their "Zone" breed or were in the process of doing so, as is shown in Table 3.

TABLE 3,—ILLUSTRATING EXTENT OF "ZONE BREEDING."

| Name. | Breed of Herd. | Zone Breed. | Herd Sire. | Remarks. |
|---|---|---|---|---|
| Miss Heppingstone | Mixed ... | M.S. | Friesian, *ex* tested dam | Sold, and M.S. purchased. |
| Mrs. Settor ... | M.S. ... | M.S. | Pure bred M.S. | |
| W. E. White ... | Ayrshire ... | M.S. | Pure bred A. ... | Considering purchase of M.S. |
| G. H. Clifton ... | M.S. ... | M.S. | M.S. *ex* tested dam | |
| R. A. Clifton ... | Jersey ... | J. | J. *ex* tested dam | |
| S. Bowers ... | Jersey ... | J. | J. *ex* tested dam | |
| A. S. Warburton ... | Mixed ... | M.S. | M.S. *ex* tested dam | |
| Mrs. Corker ... | Jersey ... | M.S. | Pure bred J. | |
| A. E. Rodway ... | J. & M.S. ... | M.S. | M.S. | |
| J. Allen ... ... | M.S. ... | M.S. | *Nil* | |
| L. Prince ... ... | M.S. & J. ... | M.S. | M.S. *ex* tested dam | |

M.S. = Milking Shorthorn. J. = Jersey.

Grade Milking Shorthorn Heifer, result of the continued use of pure bred bulls. Mrs. C. Settor, Wokalup, has a high grade milking shorthorn herd.

It will thus be seen that of the eleven competitors one did not own a bull, while no less than seven were grading up with bulls of the zone type, two were negotiating for zone type bulls at the time of inspection, and only one competitor was definitely breeding outside the zone type.

Mrs. Settor's herd of milking Shorthorn cows at Wokalup is a fine example of the value of continuity in breeding to one type of cattle, as is also Mr. G. H. Clifton's herd of milking Shorthorns at Cookernup. Mr. Clifton purchased a pure bred bull ex a tested cow only four years ago, and already has a fine herd of grade milking Shorthorn cattle.

In the Jersey zone Mr. R. A. Clifton's herd at Brunswick stands out, closely followed by that of Mr. S. Bowers, who have always had only pure bred Jersey bulls on their properties.

The principle of changing the breed of the bull from time to time is wrong, and evidently dairy farmers are realising the necessity of some fixed type in breeding if the *productions* of their herds are to be improved.

## THE REARING OF YOUNG STOCK.

As will be seen above, the size of the farms in the competition varied from 20-300 acres, the smaller farms being typical of those in the Harvey Irrigation Area.

The great problem of dairy farmers on these small areas is how to economically rear young stock to repair the wastage in their herds, and at the same time improve the quality of their herds.

On a small farm of, say, 30 acres, and which is usually highly capitalised, it is not economical to rear young stock, which are not reproductive for at least two years. The whole of such a farm is required to produce fodder for the milking herd alone, which should be kept in milk all the year round in order to meet high interest charges and irrigation water rates.

Several cases have come under the writer's notice where farmers have had to sell their heifer calves, or are only able to keep one or two from the better cows, owing to not having sufficient cheap grazing on which to pasture them.

It would seem essential therefore that on these small areas some other run or paddock should be available for the rearing of heifers and running dry stock.

Many settlers have such blocks, either on the coast or in the hills, the latter being preferable: which enables them to milk larger herds on their farms than would otherwise be the case.

The Government, recognising the necessity of some such run for the use of dairy farmers in the Harvey Irrigation Area, have set aside an excellent strip of hill country of approximately 1,200 acres, which adjoins the town boundary.

Unfortunately this area has not been developed to any extent, and does not, in its present state, carry suitable feed for young growing stock or for milch cows carrying a calf.

## PIGS ON THE DAIRY FARM.

No less than four depots handling whole milk, which is freighted to the metropolitan areas, serve the district affected by the competition, *i.e.*, one at Brunswick, two at Harvey, and one at Yarloop.

This demand for whole milk has had the effect of causing dairy farmers supplying these depots to drop the rearing of pigs, and in some cases neglecting to properly rear their heifer calves.

Only one competitior, Mr. W. E. White, at Wokalup, had developed the rearing of pigs to any extent, and had built comfortable and sanitary sties. The accommodation in all other cases for pigs was far from satisfactory, the chief fault being bad drainage leading to wet insanitary conditions. As pigs are very liable to pneumonia this no doubt accounts for heavy losses and unsatisfactory returns experienced by many farmers in the South-West, especially during the wet months.

Mr. W. E. White, Wokalup, grazes breeding sows whenever possible.

Mr. White runs nine sows and aims at marketing at least 150 porkers or baconers, some of which are bought and fattened, each year. These sows cost very little to maintain, as they are allowed only grazing until near farrowing and when suckling the litter. Mr. White has shown that by maintaining a good herd of cows, separating the milk, and feeding the skim milk to pigs, the income from the herd can be at least doubled, which return compares very favourably with that of farmers supplying whole milk to a depot, and is a more stable market.

## PASTURES.

Taking the entries as a whole the pastures were good, but varied a great deal in the character of the herbage which composed it.

On every farm where irrigation was not possible, subterranean clover formed the foundation of the pasture. With the advent of top dressing some five years ago, the response of this clover to phosphatic fertilisers made it apparent that this clover was going to mean untold wealth to the farmers of the South-West, and has been the means of putting many farmers in this district on their feet.

The practice of purchasing burr seed, however, is still very prevalent, and is not at all to be recommended. There is no better means of spreading weeds and diseases than by sowing subterranean clover in the burr obtained from farms with these pests.

The commonest weeds encountered were dock and two varieties of bartsia, one having a red flower and the other a yellow flower, this latter being particularly common round Harvey, and the writer has direct evidence that the pest is spread very quickly through the use of subterranean clover seed in the burr.

Another serious pest is dodder (*Cuscuta sp.*), and there is abundant proof that this is carried by "burr" seed. It is also suspected that the remarkably rapid spread of lucerne flea and the red legged earth mite in the South-West has been due to the almost universal practice several years ago of using clover seed in the "burr."

Second year's Subterranean Clover pasture following crop of potatoes.
S. Bowers, Brunswick.

The writer strongly advocates the purchase of clean seed. Subterranean clover, however, being an annual does not provide green feed in the summer and it is necessary for farmers relying only on this clover for pasture, to grow green fodder in the summer for the milking stock.

On farms that can be irrigated, however, this is not the case, as the pastures may be kept green all the year round. Very fine permanent pastures were seen on Mr. Prince's farm at Harvey, and also on Miss Heppingstone's farm, the latter being the finest pasture of a permanent nature yet seen by the writer.

On both these farms paspalum dilitatum with white dutch and subterranean clover form the base, the two former remaining green all the year round. In these cases it is not necessary to grow green crops in the summer. This mixture appears to give excellent results on the clay soils forming the irrigation area at Harvey.

The topdressing of pastures is universal, all farmers practising the system, the general application being 1 cwt., though some competitors put on double this dressing at the one application. The writer believes that 1 cwt. per acre is the most economical dressing to put on for pasture, and should be applied early in the autumn.

On irrigation areas, however, it is profitable to always apply two dressings. The owner of the winning farm is particularly liberal in manure, putting on two hundredweight of superphosphate in early autumn, followed in September with 1 cwt. of potato manure. Probably the second application of a manure containing some nitrogen is a wise practice, as this would have the effect of specially stimulating the grasses while the phosphatic portion of the manure would stimulate the clovers. It is believed that 1 cwt. of superphosphate in autumn followed by 1 cwt. in the spring, and the use of the harrows to break up the dung, would be found most economical.

A herd of 24-26 milking cows is maintained on the 30 acres of the winning farm and 10 acres on an adjoining farm, which is a very high carrying capacity indeed. This farm is also remarkable for the paucity of the weeds found in the pasture.

Miss C. Heppingstone's herd on Paspalum and White Dutch Clover pastures, Harvey.

## SUPPLEMENTARY FODDER CROPS AND CONSERVATION OF FODDER.

The farms gaining first and second places exemplify very clearly the two systems of farming which are necessary to maintain cows in milk throughout the year.

The first farm, that of Miss Heppingstone, an irrigation farm, relies almost solely on green permanent pasture, the second type must conserve large quantities of hay, and grow some green summer crop for succulent feed.

The lean periods of the year vary also in each case, on irrigated areas the lean period being the early winter months, from May to early August, when little growth takes place. On the larger well drained farms, where the soils are dry at the beginning of the winter, growth takes place more rapidly than on irrigated farms, where the soils are often waterlogged at the commencement of the rains, due to over use of the available water. On non-irrigable farms in this district the lean period for dairy cattle is rather longer, from January to June, during which time resource must be made to grown fodder crops and the hand-feeding of bran and hay.

On these farms it is believed that provision should be made for one ton of hay, preferably meadow hay, for every cow unit, the term "cow unit" including not only the cow but the attendant young stock also. For the cows in milk, at least one acre for every cow was looked for, as is recommended by Mr. P. G. Hampshire, the Superintendent of Dairying, in Bulletin 216, "Summer Crop Competitions."

Oats for hay, grown by Mrs. C. M. Settor, Wokalup. Variety: Algerian.

In practise with an average crop of maize of 10 tons per acre, this area of fodder fed in conjunction with hay, preferably meadow hay, will comfortably tide the herd over the lean period till the end of July.

On irrigated farms the conservation of fodder in the form of hay is not so essential, and on very small areas almost impossible. Some reserves however, are preferred, and the winning competitor, though on a small irrigated farm, intended to cut 9 acres for meadow hay.

The tonnage of hay intended to be cut for summer and early winter feeding was generally satisfactory, but several competitors outside the irrigation farms did not grow the quantity of green fodder for feeding in the summer months considered necessary.

## SMALL PADDOCKS.

The necessity of small paddocks for the economical feeding of pasture was very evident, as in every case where the carrying capacity was high, the farm was divided into numerous and small paddocks.

The winning farm of 30 acres is divided into no less than nine paddocks, which allows for rapid and frequent feeding off. Mrs. C. Settor, the second prize winner, has her farm of 129 acres divided into 16 paddocks, while Mr. White, who secured third prize, with 167 acres, 80 of which is hill country, has 17 paddocks, and the same principle was demonstrated by other competitors.

## SHELTER FOR STOCK

Shelter for milking stock is essential during the cold winter months, and to protect cattle from the heat of the sun during summer, and is a matter that has apparently received little attention when clearing many properties originally. This applies particularly to the smaller farms lying to the West of the South-West railway line. Due attention has been paid to this important item by the three placed farmers, the prize winner in particular having gone to some considerable trouble to ensure proper shelter for her stock.

## BUILDINGS.

In judging the farm buildings the following points were considered:—

(a) Suitability for the purpose for which intended.

(b) Lay-out for economical working and possible further extension.

(c) Cleanliness.

Milk sheds were required to be floored with concrete, well drained and clean, and to have suitable arrangements for handling milk or cream, and for the washing of utensils.

One of the facts that must be considered when determining whether it will be profitable to enlarge a dairy herd, beyond that capable of being handled by the farmer and his family, is the question of employing outside labour. By the use of milking machines it has been amply demonstrated in this district, that where cleanliness is observed, the herd may be easily enlarged to the carrying capacity of the farm without the need of further labour being employed for milking.

This being so it was considered necessary that the milking shed should be so designed as to facilitate the installation of milking machinery if found desirable.

This was a failing point with the second prize farm, where milking is carried out in three separate series of stalls, built on the loose box principle; the third prize winner has not yet erected a milking shed with a concrete floor, but hopes to do so in the near future.

## GENERAL REMARKS.

The writer could not but be struck by the fact that the leading farmers in the district now realise that the dairy industry does not mean the milking of cows only, but embraces such other legitimate industries as pig and poultry raising and potato growing.

No longer does the dairy farmer who, owing to his geographical position, is unable to supply whole milk to a depot, complain that the supply of butter fat to a factory does not constitute a living, as by the combination of one or more of the above avenues of revenue, the difference in price between his product sold as whole milk and that obtained when sold on a butter-fat basis is more than compensated for. This was shown by the results obtained in the competition, though numerous other instances could be cited by Messrs. White at Wokalup and S. Bowers at Brunswick, both of whom supply cream to a factory and feed the skim milk to pigs.

A shelter shed erected by Miss C. Heppingstone, Harvey. This property is exceptionally well sheltered.

The competition has made evident, what the writer has noticed for some months, that the farmers of this district are now optimistic of the future, and have a justifiable faith in the suitability of their district for the dairying industry in its widest sense.

The writer would like to thank competitors for the ready manner in which all the information desired was given, though in many cases of an intimate nature, and which assisted materially in carrying out the duties of judge.

# CLIMBING CUT-WORM OR TOMATO MOTH.

(*Chlorodea obsoleta.*)

L. J. Newman,
Entomologist.

During the past spring caterpillars of various kinds have been unusually prevalent. In some instances they have been so numerous as to constitute a plague.

The caterpillar most in evidence was the larva of the Climbing Cut-worm or Tomato Moth.

All kinds of cultivated plants and weeds are used as food hosts by this moth.

This insect is of no new occurrence here, being recorded as a pest in the State for the past 30 years, and was probably present before being officially recorded. It is an introduced insect and attacks many kinds of garden plants and weeds. This very general dietary amongst plants and its very rapid reproduction powers, render its subjugation or control exceedingly difficult.

*Description of Adult.*—It is a stout bodied moth, measuring about ¾ inch in body length, with a wing spread of about 1½ inches.

The front pair of wings are usually of a drab colour with indistinct brown markings. The hind pair are whitish in the main, the hind edges being black.

When at rest the front wings almost conceal the hind ones. This moth has a peculiar habit of vibrating its wings very rapidly when disturbed.

It belongs to the group of night flying insects, known as the Noctuidae, remaining in concealment during the day. They may be disturbed during the day and will fly off with a rapid, low, irregular movement, quickly settling and hiding again. They may also be seen in action during very dull days.

The moths feed upon the nectar of flowers or other available surface moisture.

Each female is capable of laying up to 1,000 eggs and will continue ovipositing over a period of about 16 days.

*The eggs* are tiny whitish objects, about the size of a pin head, and are usually laid singly upon the foliage. They hatch in from three to six days, according to the weather conditions.

*The caterpillars*, when first hatched, are tiny blackish objects, and have a decided preference for fruits and the nectary glands of flowers, which they bore into and spoil. A single caterpillar will pass from fruit to fruit or from pod to pod and thus do very considerable damage. Every fruit so injured is "done for," so to speak, because it quickly becomes rotten and unfit for marketing.

The larvae go through several moults during their life of 18 to 20 days. After each casting of the skin, which takes place six times, they appear with different body markings. All sorts of coloured caterpillars may be observed in a crop, but it will be found that most of them are of the same parent moth.

There is another caterpillar frequently found about the same time, namely the Green Potato Looper (*Plusia argentifera*). This caterpillar is readily distinguished by the fact that it loops the body when crawling along, and is green.

When full grown, the Climbing Cut-worm measures from 1¼ to 1½ inches in length. The body is generally marked longitudinally with light and dark lines, covered with black spots, from which soft hairs spring.

To pupate, the full grown caterpillars descend to the ground and there bury themselves to a depth of 3 to 4 inches. A chamber is formed in the soil and therein pupation takes place. Here in its earthen cell, it changes into a moth. This change may take place in two weeks or if weather and temperature are unfavourable, it may take months. When, however, the full period is reached, the moths issue from the pupæ in the soil and are in a day or two ready to propagate their species.

The pupa is about ½ inch long, brown and oblong, and is found in the soil.

There are several generations of this moth during the year. The generation of greatest economic importance is, however, the spring one. This makes its appearance in the Geraldton district about mid-August or early September. In the more southern areas, it is October, and in the extreme south November.

As the summer and consequent dry conditions become established, the pest dies down. This is due to the drying up of the cape weed and other plants, which in their green state are relished by the caterpillars. It is when these weeds dry up that the caterpillars swarm on to the cultivated green crops.

*Measures of control—Prevention.*

*Clean Cultivation.*—The importance which the suppression of weeds and clean and careful methods of farming generally bear to the control of insect pests is usually underestimated, if indeed it is realised at all.

The term weed is usually applied to any plant which is neither useful nor ornamental, but from a farmer's or gardener's point of view, any plant which is out of its proper place is equally a weed.

The entire area to be planted to a crop should be kept free of weeds and rubbish and under clean fallow for as long a period as possible before crop is grown. If land has been allowed to become full of weeds and rubbish prior to turning in and planting, many eggs, larvae and pupae will be present in the soil. As a matter of fact, many of our insect troubles are largely the fault of insanitary farming methods. It is no uncommon thing to see old useless plants left growing and the headlands and fence alignments covered with a gross growth of weeds and rubbish. Under such conditions, it is impossible to cope with insect pests.

It is useless destroying the insect in the crop if we offer them an attractive home and breeding grounds upon the headlands and fence alignments.

Volunteer plants of any crop which grow outside the actual planted area should be destroyed, unless subjected to treatment. Many weeds and crops, such as cape weed, peas, lupins, maize, young fruits and garden plants, are attacked, but the crop which suffers the greatest economic loss in the South-Western areas is the tomato.

It is, therefore, more particularly to the control of this pest on the tomato that the balance of this article deals.

Having prepared the land and planted the tomato in the manner suggested, the next preventive measure is to see that the plants are properly trained. Under the old system of allowing the plants to spread over the ground, there are many disadvantages. Tillage of the soil is impossible, picking of the fruit is laborious, fruits are seriously sunburnt, and the successful application of insecticides is rendered difficult, if not impossible.

*Trellising or Staking.*—To overcome these difficulties, it is necessary to trellis or stake the plants. The advantages of these methods over the old sprawling system are the following:—

The vines can be sprayed or dusted for insect or fungoid troubles.
The land can be cultivated and kept free of weeds.
Better quality fruit can be produced and just as early.
More plants per acre can be grown.
Picking and treatment are rendered easier.
Sunburn is largely prevented.

*Picking and destroying all infested fruits.*

Wormy tomatoes (being already rendered useless) should be gathered and destroyed. This will largely prevent sound fruits being visited by caterpillars from injured fruits. It will also destroy those caterpillars that otherwise would leave the fruits and enter the soil to pupate and give birth to further moths, whose progeny would intensify the trouble.

Tomato plants when finished with should be pulled up and destroyed by fire, together with all other rubbish on the ground, with as little delay as possible.

Land which has been under tomatoes or other susceptible crop should be ploughed as soon after as possible. Ploughing crushes numbers of insects which are in the soil and exposes others to the attacks of their natural enemies and the elements.

It is not suggested that, if the above preventive measures are carried out, an entire freedom from insect pests will be obtained. There is no doubt, however, but that clean and careful methods of cultivation result in a diminished number of those insects which reduce annually the yields obtained from the land.

*Remedial Treatment.*

*Trap Crops.*—The maize plant is a favourite host food of this moth. It is especially serviceable in luring the early spring brood. Its value as a trap entirely depends, however, on its being taken out and used as a fodder or otherwise disposed of as soon as the silking stage of the cob has been reached. If left, of course, it will only furnish a further crop of moths.

The maize should be grown in rows here and there throughout the tomato crop.

*Spraying or Dusting.*—It is not necessary to use any insecticide before the first of August, provided the land planted has been kept under clean fallow.

The first moths in the northern district would not appear before August, October in the mid-south-west and November in the south. These deposit their eggs upon the foliage. The young caterpillars, when hatched, feed here and there for two or three days before boring into any part of the stem or young fruits. It is, therefore, advisable, that arsenical sprays or dusts be applied to the foliage and green fruits.

As a routine treatment of tomatoes and potatoes this Department has persistently advised the application of Bordeaux or Burgundy mixtures as fungicides. If paste arsenate of lead is combined with this fungicide, at the rate of 1 lb. or ½ lb. of powdered arsenate of lead to every 16 gallons of the bluestone mixture, an effective combined fungicide and insecticide will be provided.

This should be applied at intervals of, say, 10 days, until within three weeks of the fruits becoming ripe.

These sprays can be obtained in ready to use form.

In combining the arsenate of lead with the bluestone mixtures same must be kept agitated and used as soon as mixed. Arsenate of lead and molasses make a good spray. Formula—2½ lbs. paste arsenate of lead, 3 lbs. molasses, water 50 gallons.

There are a number of proprietary dusting powders on the market containing arsenate of lead, bluestone, and sulphur combined, which should be very useful.

*Note.*—No poison sprays or dusts should be applied to fruit after it has started to colour. If, however, the early broods of the pest are destroyed, there should be little to fear from the Climbing Cut-worm when the ripening period is reached.

As a general bait for ground cut-worms, the following mixture is excellent:—

Bran 30 lbs., arsenate of soda or paris green 1 lb., molasses or treacle 4 lbs., water to mix to the consistency of a crumbling mash.

The bait should be distributed towards evening along the rows of plants attacked. The cut-worms come out at night and feed upon this bait and are destroyed thereby.

In conclusion, it must be again emphasised that farm sanitation coupled with well prepared land, proper cultural methods, staking or trellising of the plants, are the chief factors in the control of this pest.

The use of the sprays or dustings are supplementary.

Another very essential factor is that all growers co-operate in the fight. One neglectful grower may be the means of undoing the good work of all the others in the district.

# THE EXPORT TRADE IN APPLES AND PEARS AND REGULATIONS GOVERNING SAME.

Geo. W. Wickens,
Superintendent of Horticulture.

At the time of writing—25th November, 1928—there is every indication that the apple crop in Western Australia for the Centenary Year, 1929, will constitute a record for the State. Practically every variety has set heavily, even such in-and-out performers as "Rome Beauty" and "Nickajack" give promise of an abundant harvest, while "Dunn's" appears to have forgotten its usual alternate year cropping habit in a general heavy yield. "Grannies," "Jonathans," "Yates," "Cleopatras," and "Dougherties" have all set heavily, and so have the many other sorts which are planted less extensively than those named. Of course, many things may happen between now and the time when the fruit has reached maturity, but if nothing unforeseen and unexpected occurs Western Australian apple production in the State Centenary Year will exceed the 1,000,000-bushel mark. The highest previous yield occurred in 1927 (with 901,464 bushels), and this was followed in 1928 with 409,058 bushels, the lowest since 1921. Unfortunately, a light crop of apples does not mean high quality fruit: in fact the reverse nearly always happens: over-sized specimens, soft and liable to early decay being common in the light year. These characteristics were particularly noticeable in the 1928 crop, and it was fortunate our shipments overseas in that year comprised the comparatively small total of 169,273 bushels for much of the fruit, though of fairly good appearance at time of export, did not have the texture and keeping qualities which buyers have learned to expect in apples forwarded from Western Australia.

In spite of last season's experience it is pleasing to know that buyers are again in the field this season purchasing heavily at very satisfactory prices for shipment to European markets, and in connection with this it behoves all growers to remember that heavy crops have disabilities which, though different from those of light crops, are likely, unless guarded against, to prejudicially affect the production of high class fruit. If the trees are allowed to over-bear the fruit will be small, hard and lacking in juice, and if ever there was a season when *thinning* should be rigorously practised it is with us now, so that the name for high quality which Western Australian apples have made in the overseas markets, and which may have been somewhat tarnished last season, will be fully sustained in the State Centenary Year.

The Commonwealth Regulations governing the export of apples and pears are being tightened up, and instructions have been issued that action must be taken against any person who attempts to wilfully export such fruits as do not comply with the standards laid down.

Amendments to be brought into force in 1929, and suggested amendments for 1930 and 1931, with instructions issued regarding same are as follow:—

## COMMERCE (GENERAL EXPORTS) REGULATIONS.

*From 1st January,* 1929—

The diameter of apples and pears is to be defined as the greatest transverse measurement of the fruit taken at right angles to the line joining the stem and the calyx.

Regulation 48 (c).—Normally small apples in the standard grade of the minimum diameter of two inches bearing any signs of black spot fungus will not be allowed exportation. The minimum diameter of pears in this grade is to be reduced from 2¼ to 2 inches.

Regulation 48 (d).—A further proviso to the plain grade is to be added to prevent exportation of apples of the minimum diameter of 2 inches bearing any signs of black spot fungus. The minimum diameter of pears previously omitted from this grade is to be 2 inches.

Regulation 61.—The whole of the trade description is to be applied to one end of the case. Provision is being made to enable either the size or number of apples or pears contained in each case to be included in the trade description. Apples or pears described as 3¼ inches in diameter will include fruit of 3¼ inches, but less than 3½ inches in diameter. A new size of 3½ inches diameter will include fruit of that size or any greater diameter.

*From 1st January,* 1930—

Regulation 47 (b) is to be amended to make it compulsory for the ends of cases to be smoothly dressed.

*From 1st January,* 1931—

Regulation 48 (d), which relates to the plain grade for apples and pears, is to be deleted from the regulations.

Regulation 61 is to be amended to provide for the inclusion in the trade description of the number of fruit contained in the case in place of the optional use of the size or number of fruit. (The inclusion in the trade description of the size or number will be optional during the 1929 and 1930 seasons).

The Regulations are to be further amended as from 1st January, 1931, to provide that the export of the following varieties of apples shall be prohibited:—Alexander, Allington Pippin, Crow's Egg, Golden Pippin, James Grieve, Mobb's Codling, Prince Alfred, Peasgoods Nonsuch, Winter Majetin, Hoover Pippin, Shockley, Trivett.

It is requested that early action be taken to notify growers and exporters in your State, either directly or through the local organisations and the Press, of the proposed amendments to the Regulations, and the dates on which such amendments will probably be brought into operation.

When notifying growers and exporters of the proposed amendments to Regulation 47 (b), which is to take effect as from the 1st January, 1930, and which provides for smoothly dressed ends of cases, it should be mentioned that the increasing practice of applying the trade description by means of paper labels makes it necessary that the surfaces of the ends of cases to which labels are applied should be smooth to enable the labels to adhere firmly to the wood.

*Immature Fruit.*

An announcement will be made in the Press early next year to the effect that immature fruit will not be allowed exportation. It is pointed out that

inspectors should be instructed by the supervising officers to exercise the strictest supervision in order to detect immature fruit, particularly during the early shipments. All such fruit which, in the opinion of the inspector, is likely to arrive in the overseas market in a deteriorated condition should be rejected.

*Rejection of Unsuitable Cases.*

In view of the number of unsuitable cases submitted for export last season, the supervising officer should instruct inspectors to reject any cases made from unseasoned timber or which are unsightly, undersized, stained, warped or split to an extent which in the opinion of the inspector would be detrimental to Australia's overseas trade. Early action should be taken by the supervising officer to notify growers and exporters that such unsuitable cases will not be permitted exportation, special mention being made in regard to cases made from unseasoned timber.

. . . . . .

In order to prevent the exportation of fruit which has been prohibited exportation by proclamation, or which is not up to the standards prescribed in the regulations, or which has been misdescribed, badly packed or, generally speaking, is unfit for export, it is desired that a serious view be taken in all instances where the Regulations have been in any way contravened.

Contraventions of the Regulations are dealt with by the Collector of Customs under Part XV. of the Customs Act upon receipt of advice from the State Supervising Officers.

Unless there is strong suspicion of wilful intent on the part of the exporter to ship fruit below standard or misdescribe it in any way, no action, other than warning the firm or person concerned, should be taken in regard to the first offence for the season by any one exporter.

In regard to all subsequent offences (and in first offences also if there is suspicion of wilful intent to ship, etc., inferior fruit) the matter should be fully reported to the local Collector of Customs with a request that action under Part XV. of the Customs Act against the party concerned be taken.

## SOME NOTES ON RABBIT DESTRUCTION.

C. J. Craig,

Chief Inspector of Rabbits.

Of all the agencies of destruction that rabbits have to contend with in the struggle to exist, and to increase, the operations of man are undoubtedly the most destructive. Their numbers are reduced by carnivorous animals, parasitic diseases, the droughts of summer and the floods of winter, but the use of strychnine, phosphorous, poisonous gases and other methods of destruction applied by man easily account for the greatest numbers. The general application of poison during the main poisoning season followed during the winter with the fumigator and more poison where necessary, are the essential factors whereby the pest can be satisfactorily suppressed. But how are we to secure their effectual application? Only by organisation, adequate and effectual supervision, an abundant supply of poison at a

reasonable cost, a firm judiciary, and the removal of those conditions which tend to the conservation of the pest, and through which much of the best rural areas throughout the Commonwealth are being utilised to no more beneficial and legitimate purpose than feeding rabbits. Unless all these measures be applied rabbits are liable to increase, and one measure without the other is of little use. Numerous suggestions have been made from time to time with a view to amending the system of administrative control, but no matter what the system of control may be, or how powerful the mechanism of the Vermin Act, the degree to which rabbits are suppressed will mainly depend upon the cost and accessibility of poison and other essential materials, the methods employed, and the extent to which those responsible for their actual destruction are dominated by a sense of personal responsibility to their neighbours and the State, or by fear of loss to themselves in cash. Legislative precepts and the imposition of light penalties are in themselves insufficient to prevent neglect. Ever since rabbits became a pest—nearly 50 years ago—the best brains in the pastoral and farming communities have been centred on the problem of how best to combat the difficulty. It can only be done by work. The man who protects his property by wire-netting, poisons in summer, and fumigates and poisons in winter will not suffer serious loss. The Vermin Board's inspector, who conscientiously and earnestly advises settlers on these matters wherever it is necessary, will materially assist in solving the rabbit problem. The wonderful boom the rabbit skin market has had this winter is apt to upset some people's perspective of the pests' real position, more especially as a continual menace to our greatest national asset in the pastoral industry. Those who can review the cold facts are not blind to the reality that the enhanced value of the pelt is a great incentive to the destruction of the pest, but that to accept it as a reason for encouraging the breeding of rabbits would be to undermine legitimate industries of the land. As rabbits become more numerous, and, with an increase of the netted areas, the presence of the vermin is more keenly felt in the open spaces. Poisoning and fumigatory methods will undoubtedly keep them in check, but they are always moving and the work of the keeping them under is a continuous job. Netting the whole of the holdings must be undertaken sooner or later; in fact, a farmer cannot afford not to net. To fence a 1,000 acres farm requires about five miles of netting. This can be obtained from the Lands Department under the Commonwealth Assistance Scheme on very easy terms. The price is approximately £46 per mile or £230 for the 1,000 acres. Repayment is made on easy terms spread over 25 years. The annual payments, including sinking fund and interest on this amount, would be £16 2s., which is practically 7 per cent. on the total amount involved. If the farmer lost 15 acres of crop, with its possible yield of 13 bushels, the amount of 4s. per bushel would total £39, whereas the repayment on the netting (including sinking fund) is only £16 10s., thus an amount of £22 10s. per annum is saved. In addition the owner of a netted area has the following advantages:—

1. No local vermin rate to pay.
2. A valuable asset and less poisoning.
3. Better fence for all kinds of stock.
4. Increased carrying capacity.
5. No more killing a neighbour's rabbits.

I would, therefore, strongly recommend all Boards to urge settlers to take advantage of the opportunity afforded to obtain netting on such liberal terms.

# SORREL.

(*Rumex acetosella Linn.*)

W. M. Carne, A. B. Adams, and C. A. Gardner.

Sorrel is a weed common in the moister parts of the South-West of this State. It is particularly common on the low-lying parts of the coastal plain. However, though most frequently found on soils which are wet in the winter and badly drained, sorrel is not necessarily confined to them. It is, indeed, not particular as to soils but owing to its ability to live on sour soils it can there thrive and spread with little competition from other plants. Under better conditions it may be held in check by the strong growth of other plants such as grasses and clovers. Heavy dressings of lime are frequently recommended in other countries, but are not economically possible in most parts of this State. The beneficial effect appears to depend more on the encouragement given to competing plants than to any deleterious effect on the sorrel itself. There is no doubt that sorrel will grow on soils which do not need lime and even on well-drained sands. With us the use of phosphatic fertilisers will attain the same end as heavy dressings (two tons and upward) of lime and more economically.

Like so many other weeds, sorrel owes its importance to its effective means of spreading, and to the difficulties of eradication. In addition to seeding freely it possesses creeping underground stems which root and send up surface shoots at intervals. If these underground stems or runners are broken or cut up in cultivation, each piece is capable of new growth and of developing into a plant, hence in some cases cultivation only tends to increase the spread of the weed by distributing the underground parts. Stock spread the plants by passing undigested seeds, and sorrel has been observed growing in proximity to old cattle pads almost immediately after the land has been first ploughed and fertilised, and also on ring-barked, uncultivated country after an application of superphosphate. Sorrel seeds are a common impurity in grass and the smaller clover seeds. They are also frequently found in samples of subterranean clover burr, but not in the cleaned seed of this species.

Although it is eaten by stock, sorrel cannot be regarded as a useful pasture plant. It should be looked upon as a serious weed in all cultivated soils.

*Control.*—Preventing the weed from becoming established is, of course, preferable to attempting its eradication at a later date. As soon as it is noticed it should be forked out and burned, remembering that the destruction of the underground parts is essential. On larger areas the land may be ploughed in the early spring before the plants have an opportunity to flower, following up with a spring-tyne cultivator as often as may be necessary during the summer. This has the object of bringing the underground stems to the surface, that they may be destroyed by exposure to the heat of the sun. With the first rains of the following season oats, or some other heavy smothering crop, should be sown.

The use of lime, so often advocated for the destruction of sorrel, is not in general an economic or effective method of control in Western Australia. Its success in Great Britain and elsewhere is probably due to its beneficial effects upon other vegetation enabling the latter to crowd out the weed.

The most economical method of dealing with sorrel in badly affected areas is to put the land under pasture. Eradication by means of cultivation is slow and comparatively expensive, and it is doubtful if it pays to keep land in cultivation when it is badly infested with sorrel.

If clovers, particularly Subterranean Clover, are established on infested soils, and top-dressed regularly with superphosphate, the sorrel will disappear in time. In the meanwhile the clover will give a good return as pasture. If the soil is wet or poorly drained, Drooping-flowered clover (*T. cernuum*) is superior to Subterranean Clover. Drooping-flowered clover is becoming quite common on the moister soils of the South-West, and usually becomes established without sowing. This is fortunate as seed is rarely available for sale.

*Description of Plant.*—A perennial herb, with a creeping rhizome, and slender erect stems 4-18 inches in height, often turning red. Leaves alternate, the lower ones usually hastate or sagittate at the base, the upper ones usually narrower, to lanceolate, or even linear, all glabrous, petiolate. Stipules thin and scarious, usually white or silvery, forming a ring or sheath around the stem. Flowers small, dioecious, in slender terminal panicles, the clusters numerous, few-flowered, without floral leaves. Perianth-segments 6, broadly ovate or orbicular, entire, obtuse, the three inner ones slightly smaller, and closing over the fruit. The male flowers have six stamens. The female flower has a triangular, one-seeded nut which is usually longer than the perianth segments, and bears when in the flowering stage a three-pronged stigma.

For further particulars see plate. The habit of the plant is usually erect, but is exceeding variable. Fully developed plants, which are dwarfed, can be always seen in some situations. The shape and size of the leaves also vary. The plant illustrated is a tall grown form from Maddington, in sandy soil; the separate leaf is taken from a smaller more robust plant grown in heavier soil.

## SORREL.

*Rumex acetosella.*

Explanation of Plate.

A. Habit (half natural size).

B. Leaf, natural size.

C. Male flower.

D. Anther.

E. Female flower.

F. Fruit.

G. Seed.

H. Section of seed showing triangular shape.

SHEEP SORREL.

(*Rumex acetosella*, Linn.)

# DROOPING-FLOWERED CLOVER.

(*Trifolium cernuum*, Brot.)

W. M. Carne, C. A. Gardner, and G. K. Baron-Hay.

## DESCRIPTION OF PLANT.

A glabrous annual herb, normally diffuse, but frequently in favourable situations so dense that it forms thick masses of up to one foot in height or more, the stems weak, hollow and ascending. Leaves on long petioles, leaflets obovate or ovate-cuneate, denticulate, more or less strongly veined. Flowers pale pink, very small, numerous in loose pedunculate heads, each flower shortly pedicellate. At the time of flowering the flowers are erect or spreading, but after fertilisation the flowers are bent downwards (reflexed). Standard notched at the apex, not much longer than the calyx. Pod included in the calyx, 2-3 seeded. The plant is native to Spain and the Mediterranean region.

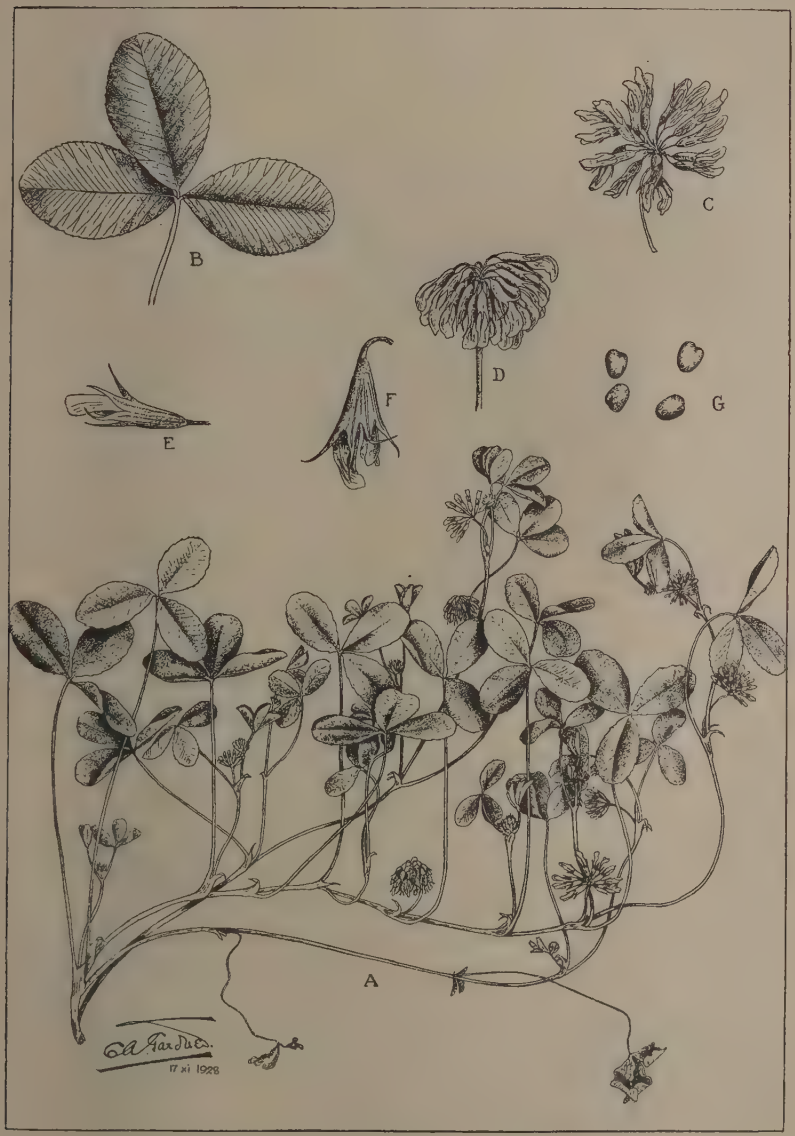
According to Mr. W. C. Grasby, it has been known to occur in Western Australia for at least twenty years, being first noted by him at Gingin, and known as "Gingin Clover." It is now widely distributed throughout the South-West, the South Coastal and Great Southern districts. The plant is known in the South-Eastern districts of South Australia, but has not yet been recorded in Victoria or the other Australian States.

Unlike Subterranean Clover, the Drooping-flowered Clover prefers moist, or even wet soils, and will withstand inundation in the winter months, but in drier soils it is not as successful as Subterranean Clover. The two clovers complement each other; one confined to moist depressions and the other to the better drained soils, the line of demarcation being frequently quite distinctly marked.

In favourable places Drooping-flowered Clover is as prolific as Subterranean Clover, has finer stems, and is as readily eaten by stock, if not preferred. The seed is light yellow and very small. It is produced in great quantity, and resembles that of Cluster Clover, but has a more prominent radicle. Unlike Subterranean Clover, which has the seeds contained in "burrs," the seed of Drooping-flowered Clover falls out of the small pods, and may be seen as a yellow layer covering the soil when the mat of clover is lifted after it has dried off. The seeds are not usually obtainable through the ordinary channels of seed-trade, but small parcels are sometimes available from farmers. The price ranges from eight to twenty shillings per pound, and the seed contains a varying amount of impurities according to the method adopted in harvesting. The best method of gathering seeds is to wait until the first seeds commence to shed, then cut the clover and spread the plants on a canvas or other sheet, which collects the seeds as they fall.

The percentage of hard seeds is frequently high. Ten pounds of clean seed collected in 1924 gave poor results on wet flat treeless country at Young's Siding during the first year, but excellent results were obtained in subsequent seasons. It has been found on the semi-swampy areas to the west of Harvey, Yarloop and Waroona, that applications of superphosphate were necessary to induce this clover to grow, and the same has been demonstrated at Wagerup.

In making hay from Drooping-flowered Clover the plants should be cut when in flower, as the ratio of fibre increases as the seeds develop.




DROOPING-FLOWERED CLOVER.
(*Trifolium cernuum*, Brot.)

*Explanation of plate.*

1.—Portion of Plant (half natural size) showing ascending habit.

B.—Leaf (natural size).
C.—Flowering head (natural size).
D.—Fruiting head (natural size).
E.—Flower × 4.
F.—Fruiting calyx × 4.
G.—Seeds × 4.

## POTATO CHIPS.

G. N. LOWE,
Senior Potato Inspector.

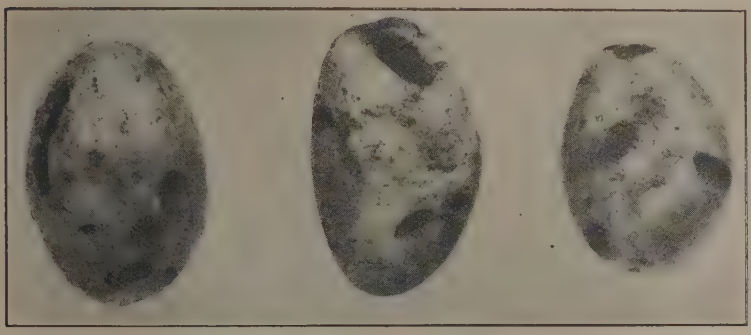
*Mixing Fertiliser.*—A cheap, simple and effective method for the mixing of fertilisers was recently noticed when the writer was on the property of Mr. "Cedar" Armstrong near Yallingup.

Mr. Armstrong, as is the case with numerous other potato growers, pins his faith to fertiliser of his own composition, and, instead of using a shovel to turn the ingredients on a floor as is the usual way, pours his materials in their respective quantities on to an old sail which he has had for some years, taking care that he then spreads each quantity in a thin layer over the last. Then grasping a corner of the sail in each hand he walks forward to somewhere near the opposite side, lifting and lowering each corner as he progresses. This is repeated from each side in turn, when the mixing is thorough and complete and only takes a matter of a minute or two. By placing on the "mixer" (a square piece of hessian will do quite well) just what the operator can comfortably lift, the whole mass can then be—after mixing—poured into a bag suspended conveniently.

*Observance of directions for dipping in warm formalin mixture.*—The following illustrations depict the necessity for the strict observance of directions when dipping seed in warm formalin solution as recently described in this journal. Indeed, strict adherence to the correct formula is naturally vital to the success of any similar operation, and it is astonishing how often the writer in his travels finds instances where growers have either—"off their own bat" or because a neighbour does so—made some variation as to time, strength of solution or wrong ingredient in a preventive or curative treatment, and then condemn whole-heartedly and utterly all such treatments instead of their own pet variation of them.

Seed dipped in warm formalin solution and kept covered for one hour only (the correct period) after dipping.

Illustration No. 1 shows seed dipped for *two minutes* in the formalin solution composed of 2 pints of formalin to 30 gallons of water warmed to *120 degrees* Fahrenheit and kept covered for *1 hour only* (the correct period) before turning out to dry in the open.



This seed was kept covered for 24 hours after dipping, prior to racking. Note the injury occurring.

Illustration No. 2 depicts what happened after holding the seed under cover for 24 hours before drying off, although the other directions were observed.

Tuber kept covered for 48 hours after dipping. The injury is much greater, and may easily cause rotting when planted.

Illustration No. 3 shows a marked increase in the pitting and injury to the skin of the tuber, and this is accounted for by the fact that the grower submitting the sample left the seed covered for 48 hours before turning it out on to his racks.

The injury has all the appearance of the well-known storage trouble, and although it has not completely ruined the tuber from a seed standpoint, it cannot well be claimed that this particular "over thoroughness" is an improvement, to put it midly.

*Lower Kalgan Country.*—The latest district to provide excellent seed under the Certified Seed Scheme is the hill country on the Lower Kalgan about 12 miles east of Albany. In this district, hill lands timbered largely with a mixture of red gum and yate, and of rich chocolate soil can be planted in March and harvested in July, and so provide seed much sought after by the swamp growers of Narrikup, Redmond and along the Denmark line, who plant in October and November.

Fine crop of Delaware, grown by Mr. H. C. Poole, Lower Kalgan.

A very keen and careful grower in Mr. H. C. Poole, together with Messrs. A. & J. Hopson, who also are growing good crops, were successful this season in having the bulk of their yields certified to and were able to dispose of all their surplus immediately at highly remunerative rates. It is expected that this seed will make its presence felt in the next cropping.

A very fine opportunity for careful growers in the Lower Kalgan district exists for the provision of similar seed for the Great Southern swamp areas,

and although last season with its early dryness, and heavy winds and wet towards maturity, certainly were not ideal from a standpoint of heavy yield, returns of from 6 to 8 tons per acre were obtained.

Mr. Jack Hopson pondering as to how he will invest the proceeds of this excellent crop of Delaware.

*A world's record yield on an acre.*—What potato grower would not like to produce 27 tons 17 cwt. of tubers on one acre of land?

The feat, which it is claimed is a world's record, was accomplished last year in California by Messrs. Zuckerman Bros., who annually crop about 1,500 acres of peat lands under irrigation.

Those growers at Young's Siding who have grown up to 20 tons per acre on portion of their peat soils have now something for which to strive!

# THE TREATMENT OF BOWLING GREENS, TENNIS COURTS AND LAWNS.

The following notes have been put up by officers of the Department as numerous requests for information in connection with the treatment of tennis courts and bowling greens have been received:—

1. Periodical forking of the ground to a depth of 6 or 8 inches in order to aerate the soil should be practised during the winter and before the annual levelling process, say, in July.

2. Unless the land is known to be of limestone formation, as is the case in some parts of Cottesloe and Fremantle, it is advisable to apply in July, once in two years, a dressing of "quick" or builders' lime, after it has been water slaked to a powder, at the rate of 4 ozs. per square yard—

| | |
|---|---|
| Tennis Court (120ft. x 60ft.) ... ... ... ... | 200 lbs. |
| Bowling Green (120ft. x 120ft.) ... ... ... | 400 lbs. |
| Bowling Rink (120ft. x 20ft.) ... ... ... ... | 66lbs. |

If air slaked lime or agricultural lime is used, double the amounts stated should be applied.

3. Early in August apply muriate of potash or sulphate of potash at the rate of 2/5th oz. per square yard—

| | |
|---|---|
| Tennis Court ... ... ... ... ... ... | 20 lbs. |
| Bowling Green ... ... ... ... ... ... | 40 lbs. |
| Bowling Rink ... ... ... ... ... ... | 14 lbs. |

and superphosphate at the rate of 2 ozs. per square yard—

| | |
|---|---|
| Tennis Court ... ... ... ... ... ... | 100 lbs. |
| Bowling Green ... ... ... ... ... ... | 200 lbs. |
| Bowling Rink ... ... ... ... ... ... | 33 lbs. |

4. If diammonphos (or "Floraphos") is to be used for supplying the nitrogen, as in paragraph 6, then the dressing of superphosphate can be omitted.

5. The application of muriate of potash or of sulphate of potash and superphosphate in August should be followed by a light scraping of clean sand in the case of bowling greens or stiff loam for tennis courts, just sufficient to secure a smooth level surface. The object of this annual levelling is to fill up the worn places, and as the addition of sand or other material has little or no nutritive value, and in consequence the dressing for the levelling process should be as light as possible, otherwise much of the grass will be destroyed and the use of the lawn delayed. The later the levelling is left the quicker the surface is fit for play, as couch grass only grows profusely in the heat of summer.

6. Following the levelling process the ground should receive an application of nitrogen, either in the form of sulphate of ammonia, nitrate of soda or diammonphos ("Floraphos") at the following rates:—

| | |
|---|---|
| Sulphate of Ammonia ... ... ... ... or Diammonphos or Floraphos ... ... ... | 1/8th oz. per sq. yd. |
| Tennis Court ... ... ... ... | 7 lbs. |
| Bowling Green ... ... ... ... ... | 14 lbs. |
| Bowling Rink ... ... ... ... ... | 2½ lbs. |
| or | |
| Nitrate of Soda ... ... ... ... ... | 1/6th oz. per sq. yd. |
| Tennis Court ... ... ... ... | 9 lbs. |
| Bowling Green ... ... ... ... | 18 lbs. |
| Bowling Rink ... ... ... ... | 3 lbs. |

7. The application of these nitrogenous fertilisers should be continued monthly for the period during which the greens or lawns are to be used; after the first two applications the quantity may be reduced to half the above amounts.

8. The fertilisers can be distributed in the dry form by hand with or without a mixture of sand to ensure even distribution, as liquid fertiliser through a watering can, or by means of the "Floraphos" distributor, which enables the fertilisers to be applied in liquid form whilst the greens are being watered.

9. To ensure a hard compact surface for play the mowing should precede the sprinkling, and this in its turn should be followed by rolling.

## THE SUMMER GROWING OF POTATOES.

W. E. COLLINS,
Potato Inspector.

Potatoes grow in many climates, but temperature is a limiting factor. The optimum soil temperature is around 65 deg. F. Heavy production cannot be obtained with very much variation from this range. It is very difficult to measure the adverse effect of too high a temperature, but it undoubtedly has more effect at certain times in the life of the plant than at others.

High temperatures at the time the young tubers are forming is likely to be harmful unless all other conditions are just right.

The potato is particularly sensitive to irregularities in both temperature and moisture. Tuber formation begins when the plants are five to six inches high, and is completed by the time the flower buds are formed.

Conditions during this period determine the number of tubers formed. Many crops have indicated by their vigorous growth and large tops, prospects of heavy yields—only to disappoint; the grower on digging finding an average of three or four tubers only to the plant. A spell of hot weather at the tuber forming period was undoubtedly one of the reducing agents. From the beginning of the flowering period until the plants are dead, the tubers grow at a regular rate if uniformly favourable conditions exist. Hence conditions during this period determine the development of the tubers, especially as to size, smoothness and shape. It has been noted that under certain conditions tubers tend to elongate and develop the "carrotty" type. This, certainly, may be associated with dry hot summers.

While factors other than soil temperature may influence the size of the tubers, it is recorded definitely that soil temperature is an important factor in determining their shape.

The writer has in mind stocks of Delaware potatoes held on racks for seed purposes, at the Department of Agriculture during the season of 1926. These having been dug from the peat swamps at Young's Siding, from the Benger Swamp, some from the Collie River flats, whilst others were grown in moist black sand on the Peel Estate. The comparison was astounding, those from Young's Siding being long—up to 18 inches in length—cucumber-shaped, with an equal diameter from end to end.

The tubers from Benger Swamp were the extreme opposite, being dumpy and round. The Peel Estate potatoes, on the other hand, were flattened and wide, tapering slightly at each end. Only those from the Collie River flats conformed most nearly to what is judged to be good Delaware type.

The above were shown to Mr. × (potato expert of Victoria, just then on a visit to this State), and he was asked to express an opinion as to whether they were four distinct varieties. Mr. × was both confounded and nonplussed when informed that they were not only the one variety, but had been grown from the same stock in each instance.

There is a growing idea that seed from Southern districts is more vigorous than that from more Northern localities. Certainly, it is true that potatoes grown under cool, humid climatic conditions are better than those grown in hot sections. Seed grown in the Denmark area, with its more nearly ideal potato-growing season, may equal or surpass in producing quality that grown in the South-West. Climate, no doubt, has some direct effect on the vigour of seed potatoes, it also has been found that high temperature mask the effect of certain diseases, especially Mosaic, so much so, that it is not possible to rogue out the diseased plants effectively from crops intended for seed. These diseases are manifested more clearly in cooler, moister sections. Thus, the climatic factor may have much to do with the elimination of diseases such as Mosaic, which under severe climatic conditions weakens the plant without being readily visible.

There is another factor in location too. Some places are relatively free from aphids and other insects, and therefore enjoy a natural advantage in production of healthy seed. Where the potato-destroying insects occur in large numbers it is impossible to keep up disease-free seed stocks, even when some "rogueing" is done.

It seems very probable that soil temperature may in part account for the irregular results obtained in much of the seed treatment for scab control. There is some indication that excessive scabbing is largely due to the fact that tuber development takes place most times during the hot part of the season.

Very frequently growers report good results from certain seed treatments, and in following years the same treatment may fail to wholly control the disease on the same soil. Soils containing only a moderate infestation of the scab organism would not produce much scab during a cool year, whereas a considerable amount of the disease would be likely to occur during a hot year, even though the seed be well disinfected. Of course, it must not be forgotten that other influencing factors, such as soil moisture, lack of humus also play their part with soil temperature in explaining such irregular results in seed treatments. Other defects connected with unusually hot weather are "fleck" and "black heart." The former, an internal browning, appearing as streaks or isolated brown dead spots in the middle portion of the tuber. If the weather is hot and the soil dry, this type of injury may be reduced by digging the tubers as soon as the tops begin to die. "Black heart" is a result of suffocation of potato tissue. Purplish-black discolouration internally may arise from too high temperatures or poor ventilation, or a combination of both. Newly dug potatoes exposed too long to the hot sun may be seriously over-heated. Hot, ill-ventilated sheds is another cause. Cool airy storage is the preventative.

High temperatures at the time of planting may be a serious factor. In hot soils excessive rotting of the seed pieces has been observed. No means of preventing this decay has yet been found. The healing of the cut surface by means of the "wet bag treatment" prior to planting offers the most promising line of attack.

Recorded soil temperature in unshaded soil at a depth of two inches averages from 1 deg. to 8 deg. higher than shaded air temperatures. When the same soil is shaded the temperature is approximately the same as the air temperature. In a potato field we have the latter condition, and soil temperatures at about four inches will average from 1 deg. to 2 deg. below the air temperatures.

# MOISTURE AND NITRATE FLUCTUATIONS IN MULCHING EXPERIMENT PLOTS,

## STATE EXPERIMENT FARM, MERREDIN.

L. J. H. Teakle,
Plant Nutrition Officer.

The study of nitrate and moisture fluctuations in soils has been carried out in other parts of Australia and in other countries of the world. It has been found almost invariably that cultivation favours the accumulation of nitrate in the soil solution and also economises the soil moisture due to the killing of weeds and the formation of a soil mulch. In order to better evaluate the benefits of fallowing and to study methods suitable for the attack of our soil problems in Western Australia, it was decided to sample systematically the soils in the mulching experiment plots at the State Experiment Farm, Merredin, during the year 1928. Sampling was commenced in February and continued at intervals until the end of October when the wheat was in the dough stage. It is probable that another sampling in February, 1929, will prove fruitful as indicating the recovery of the soil but the information is sufficiently complete at this stage to review the results and to publish them for the possible benefit of those interested in soil science as well as in soil products.

## METHODS ADOPTED.

The mulching experiment plots were selected as being suitable for preliminary work, and were sampled by means of a 1½in. auger to a depth of about two feet. In certain instances this depth was divided into—

1. mulch—the loose surface soil;
2. first foot under the mulch;
3. second foot under the mulch.

During the growing period it was impracticable to sample in such detail only the first foot being sampled. Each plot was sampled at three sites—

1. near the south end;
2. in the middle;
3. near the north end.

At the final sampling in October the samples were only taken at the ends in order to avoid damaging the standing crop. As each plot was replicated five times, each treatment was represented by at least ten or fifteen samples. The soil was placed in tins, and bacterial action checked by means of toluene which was applied in pieces of cotton wool. The tins were closed by means of lever top lids, which were vaselined to improve the contact and make a more effective seal. It was necessary to transport the samples to Perth for analysis.

The plots were treated as follows:—

1. Fallow cultivated after ploughing, and thereafter following every twenty-five points of rain.

2. Control. Fallow cultivated after ploughing and before seeding.

3. Neglected Fallow. Cultivated before seeding only.

It must be remarked that owing to the abnormally dry summer the difference in the actual cultivations, which the plots received was small so that very similar results would be expected. Of course, local anomalies invariably occur due to the great variability of the soil, but these differences are ironed out when the averages are considered.

The results of the analyses are given in Table 1 and Table 2. The curves in Figure 1 and Figure 2 show the fluctuations of moisture and nitrate in the soil of the first foot in the plots.

TABLE 1.

*The moisture contents of plots of the Mulching Experiment, State Experiment Farm, Merredin, during the season of* 1928. *The plots were seeded on* 30*th April*, 1928.

| Date of sampling. | Treatment 1—Fallow cultivated after ploughing and thereafter following every fall of 25 points or over of rain. | | | Treatment 2.—Control. Fallow cultivated after ploughing and before seeding. | | | Treatment 3.—Neglected Fallow. Fallow cultivated before seeding only. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mulch. | 1st foot. | 2nd foot. | Mulch. | 1st foot. | 2nd foot. | Mulch. | 1st foot. | 2nd foot. |
| | Water. | Water. | Water. | Water. | Water. | Water. | Water. | Water. | Water |
| 1928. | % | % | % | % | % | % | % | % | % |
| Feb. 28 and 29 | 1·63 | 7·94 | 12·57 | 1·40 | 7·10 | 11·38 | 1·62 | 7·44 | 9·77 |
| April 23 and 24 | 2·43 | 9·29 | 11·88 | 2·93 | 9·52 | 11·46 | 2·88 | 8·83 | 10·39 |
| June 26 ... | ... | 9·57 | ... | ... | 9·26 | ... | ... | 9·14 | ... |
| July 30 ... | | All samples were high in moisture averaging 13% water. | | | | | | | |
| Oct. 26 and 27 | ... | 4·92 | 9·49 | ... | 4·68 | 9·05 | ... | 3·68 | 7·20 |

TABLE 2.

*The Nitrate contents (pounds of nitrate nitrogen in one million pounds of soil) of plots of the Mulching Experiment, State Experiment Farm, Merredin, during the season of* 1928. *The plots were seeded on* 30*th April*, 1928.

| | Treatment 1.—Fallow cultivated after ploughing and thereafter following every fall or 25 points or over of rain. | | | Treatment 2.—Control. Fallow cultivated after ploughing and before seeding. | | | Treatment 3.—Neglected Fallow. Fallow cultivated before seeding only. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mulch. | 1st foot. | 2nd foot. | Mulch. | 1st foot. | 2nd foot. | Mulch. | 1st foot. | 2nd foot. |
| 1928. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs |
| Feb 28 and 29 | 25·3 | 10·3 | 11·1 | 24·2 | 8·5 | 15·0 | 11·4 | 4·9 | 10·2 |
| April 23 and 24 | 12·2 | 8·1 | 3·8 | 11·5 | 10·0 | 6·5 | 14·2 | 4·1 | 3·6 |
| June 26 ... | ... | 10·0 | ... | ... | 10·9 | ... | ... | 9·4 | ... |
| July 30 ... | ... | 3·3 | ... | ... | 2·5 | ... | ... | 1·8 | ... |
| Oct. 26 and 27 | ... | 1·6 | 0·7 | ... | 1·1 | 1·4 | ... | 0·9 | 1·3 |

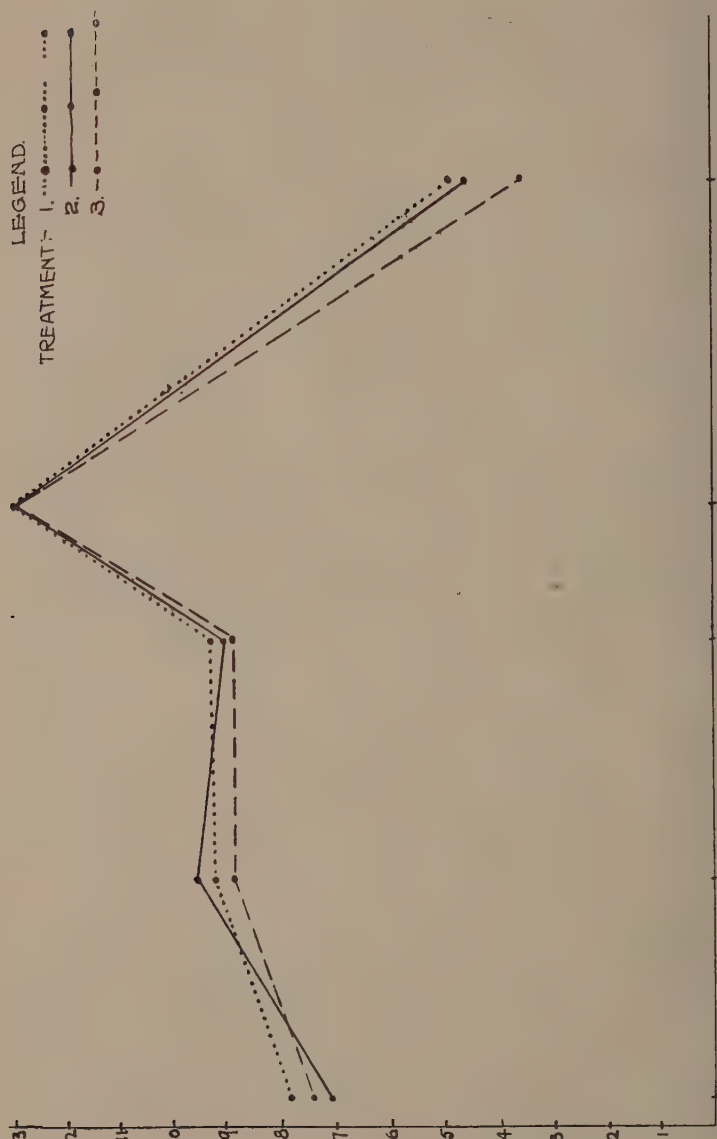



Fig. 1.—Fluctuations in moisture content of the first foot of soils from the Mulching Experiment Plots, State Farm, Merredin.

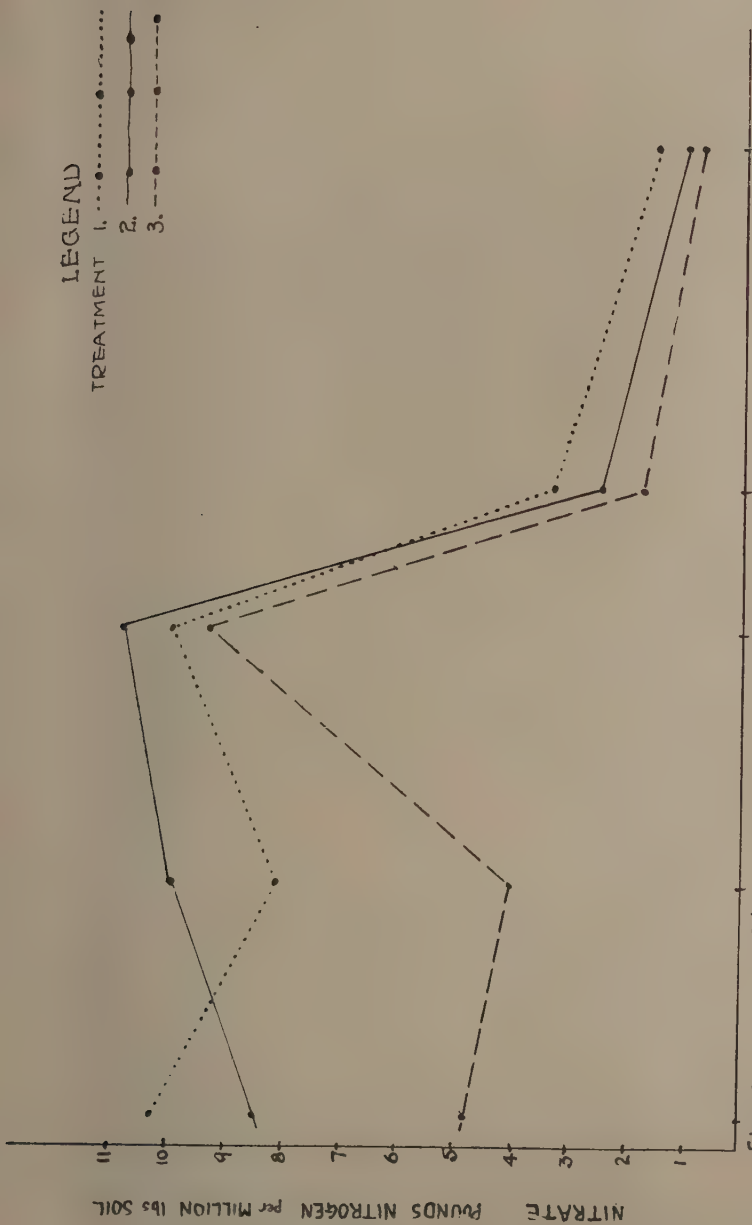



Fig. 2.—Fluctuations of nitrate nitrogen in the first foot of soils from the Mulching Experiment Plots, State Farm, Merredin.

## CONCLUSIONS.

Insufficient information has been obtained in the short time available for any general conclusions to be suggested. It will be necessary to continue the work over a number of years in order to evaluate the seasonal and other factors. Certain features, however, are manifest.

1. The growing crop absorbs nitrate from the soil faster than it is replenished by soil processes. This normally occurs in cropped soils, the nitrates being more or less completely absorbed by the time the crop is beginning to run to head.

2. The soils of these plots are well supplied with nitrate nitrogen, particularly if cultivated. Reckoning an acre foot of soil as weighing four million pounds it may be calculated that on 28th February, 1928, the plots under the control treatment 2 contained about 120 lbs. of nitrate nitrogen per acre in the surface 2 feet. Similarly those under treatment 3 contained 70 lbs., and under treatment 1 180 lbs. of nitrate nitrogen per acre, in the surface 2 feet. When it is remembered that a considerable portion of this supply is present in the mulch just where the young seedling will need it, it seems that the salmon gum and gimlet soils at Merredin must be well supplied with nitrate nitrogen for the young crop. Warrington states that 50 lbs. of nitrogen are required for a 30-bushel crop. It seems hardly likely that nitrate is the limiting factor in the Mulching Experiment Plots at Merredin.

3. The treatments did not affect differentially the moisture content of the layer of soil to a depth of one foot. There seems however, a real difference in the moisture content of the soil between 1 foot deep and 2 feet deep. The difference is in favour of the cultivated plots (treatments 1 and 2) to the extent of about 25 tons of water per acre, which is equal to about 25 points of rain. Apart from the improved physical condition of the soil resulting from the cultivation and a greater freedom from weeds it seems that at the beginning of the season the cultivated plots are chemically in a better condition than are the neglected fallow plots. The grain yields during the period 1916 to 1927 show a 6 per cent. improvement, resulting from fallow cultivation in the spring, thus correlating quite well with the results obtained in this study.

Acknowledgment is made of the assistance of Messrs. G. L. Throssell and G. Burvill in the work at Merredin. The analytical work was performed in the laboratory of Professor Paterson at the University of Western Australia. Thanks are due for the use of the facilities and apparatus made available for this work at the University.

# MINERALS AND THE HEALTH OF CATTLE.

A. B. Adams.

Much water has flowed under the bridge since the writer penned an article on the above subject (W.A. Dept. of Agric., "Jour.," Vol. I., No. 2), and, as during the time that has elapsed since its publication, it has been realised that the losses due to mineral deficiency are even more serious and widespread in the State than was realised at the time, and as, further, throughout the world mineral deficiency in stock has been the subject of numerous experiments by research workers, the time is now ripe to further consider the position and amend our practice in the light of modern knowledge.

To touch first on our local experiences: In 1924 it was realised that stock became cripples, or even died from malnutrition, and possibly died from chewing carrion that had been infected with a bacillus producing a poison, We now know that deaths from carrion poisoning are widespread. These deaths in the majority of cases were so sudden and so similar to plant poisoning that plant poisons were almost invariably thought to be the cause. In many cases, however, close search failed to reveal any poison plants and enquiry nearly always elicited a history of bone chewing.

Now the practice of giving phosphatic licks to stock has become more general, and this is a great advance, but there is great room for improvement in the simplification and cheapening of the licks used.

In the previous article, the writer was inclined to lay stress on the importance of the proportion of lime to phosphate; in this, following Ingle. Certainly some local experience appeared to bear this out, as cattle that had a change to the limestone soils of the coast from the inland soils deficient in lime were not so subject to cripples. On the other hand, some farmers, who did not change their cattle, stated that by the use of bran they kept their stock healthy and free from cripples.

We now know that the diseases which Ingle attributed to excess of phosphoric acid with a deficiency of lime was not a deficiency disease, but was of bacterial origin.

The present position, as regards local knowledge and recent work in other parts of the world, may first be glanced at. We may then profitably consider the best and most economical methods of tackling our troubles.

Within the State we know, definitely, that a deficiency of bone-forming material in the feed is a cause of serious loss to stock owners. In addition to the deaths of stock, both sheep and cattle, from chewing bones and carrion infected with the poison producing organism, there is probably an enormously greater loss every year from inferior development, lessened production of meat, milk products, wool, and last, but probably not least, irregularity in breeding.

We know further that these troubles can usually be overcome by the provision of licks containing phosphate, and by fertilising our pastures with superphosphate.

Our local knowledge and experience has not thrown much light on what is really the best lick to use. Those in general use are some one of the proprietary licks or sterilised bone meal, super., or basic super., and ground rock phosphate, according to fancy and obtainability, either alone or mixed with lime, common salt, sulphate of iron, etc.

Of investigations pursued in other countries, those of Sir Arnold Theiler and his co-workers in South Africa have many lessons for us showing us the elements which are most essential with their relative importance.

Considering their results and conclusions the following lessons are learnt:

1. Cattle suffering from a serious deficiency of phosphoric acid in the feed become cripples, and eventually die if not relieved.

2. An excess of lime does not make up for deficiency of phosphoric acid; on the contrary, extra lime renders the small amount of phosphoric acid less available and produces cripples sooner than would be the case with less lime.

3. Cattle receiving plenty of phosphoric acid in the shape of a liberal bran ration with a very limited amount of lime grow normally and do not develop cripples.

4. Common salt, though necessary, was not required in large amounts; animals making normal growth on much smaller quantities than are usually taken by the animal when it has free access to salt.

5. An experiment carried out at the same time showed that disease, due to lack of vitamins A, B and C, was not likely to occur under any natural conditions of cattle raising.

There is no reason to think that Western Australian stock suffer from lack of minerals other than phosphates, except possibly on comparatively small areas. The supply of a sufficiency of phosphoric acid usually ensures healthy growth.

In the light of the above results, and taking advantage of Queensland experience given below, there is much room for the simplification and cheapening of the licks used, our object being the supplying of a sufficiency of digestible phosphoric acid as cheaply as possible.

Possible sources of phosphoric acid are finely ground Nauru or Ocean Island rock phosphate, basic superphosphate, or sterilised bonemeal, taking them in their order of cheapness per unit of phosphoric acid.

At present the publication of the analysis of proprietary licks is not compulsory, but it is common knowledge that some of them contain much common salt. In the absence of a published analysis it is impossible to criticise all the ingredients and to consider how far they are useful. These prepared licks probably serve a useful purpose in stressing the importance of a supply of mineral matter, and may be convenient where they do not need mixing. The careful stock owner, however, will do well to consider the supply of phosphoric acid in a cheaper form, this being the substance which we know to be lacking in almost every portion of the State. It is time enough to consider the supply of other minerals when it is found that animals fail to thrive when supplied with sufficient phosphoric acid and common salt.

Of the substances given above, finely ground rock phosphate should be used much more extensively than it is, as not only does it contain a very high percentage of phosphoric acid it is also safe to feed without being

first sterilised. It has but one disadvantage, stock do not recognise it as a substance containing phosphoric acid, and therefore will not take it by itself. This difficulty may be overcome in any of the following ways:—

(1) If the stock are being hand-fed, the phosphate may be fed mixed with the feed.

(2) If not being hand-fed, the phosphate may—

(a) be mixed with a small amount of bran or pollard or other meal, and fed in boxes, allowing one or two boxes more than the number of animals to give the weaker ones a chance. If the herd is large a yard may be erected between two paddocks, a convenient number allowed into the yard at one time, and as soon as they have consumed their handful of meal and phosphate, which will take a very short time, passed out and another lot admitted;

(b) be mixed with enough salt to give it a salty taste, and given as a lick, and then the animals will obtain sufficient salt and the necessary phosphate. The stock owner is advised to have as low a proportion as possible of salt to make sure that the animals take sufficient phosphate; too much is better than too little phosphate; it is possible to take too much salt.

It has been stated that Nauru phosphate has caused digestive troubles among sheep, owing to its high percentage of insoluble silica.

This statement is not correct, as Nauru phosphate is almost pure tricalcic phosphate of lime, and on treatment with acid dissolves, leaving a negligible residue.

As to causing digestive troubles, the following letter received from Mr. Brunnich, Agricultural Chemist to the Queensland Department of Agriculture, speaks for itself:—

Department of Agriculture and Stock,
Brisbane,
5th November, 1928.

Dear Sir,

Some have for some time tried to belittle the value of Nauru phosphate as a lick, and made repeatedly statements that such phosphate causes digestive troubles, with ulceration of the intestines, etc., and therefore during my last trip through a large portion of our sheep country I made a special enquiry into this question and could not find any case where Nauru phosphate used as a lick had caused the slightest trouble during the last three years.

In all cases the reports on the results following the use of Nauru phosphate licks are most encouraging, and in some cases the results are quite phenomenally good, one owner reporting an increase of his average holding of 40,000 sheep up to 85,000 during the last years of the drought, by the use of several hundred tons of Nauru phosphate, and he also reports general improvement in health, practical disappearance of bottle and worm troubles, and great reduction of losses due to blowflies, and he is positive that he never found the slightest signs of digestive troubles. Salt, used as a lick, has in the past years of drought caused serious troubles and thousands of sheep died all over the State due to salt poisoning.

My advice is to give less salt and more phosphate in the form of licks to cattle and sheep.

Nauru phosphate being not only cheaper but contains so much more phosphoric acid than bone meal, and does not require sterilisation, is an excellent substitute for the latter, and my latest recommendation is the use of one part of salt, not too coarse, two parts ground Nauru phosphate, Only very occasionally the addition of Iodine, Sulphur, etc., may give beneficial results.

(Signed) F. BRUNNICH,
Agricultural Chemist.

Mr. Brunnich's letter is most interesting and informative, showing as it does that Nauru phosphate is suitable as a lick in all conditions if sufficiently finely ground. The warning that it is possible to give too much common salt is also important.

As was pointed out in the previous article, the deficiency is most pronounced when the pasture is dried up, the stockowner is therefore urged to make sure that his stock are receiving a sufficiency of phosphate during the summer.

When the phosphate is given as a lick for the stock to help themselves, the stock-owner's chief concern will be to see that the trough contains a supply of lick, and that it is not contaminated with droppings. He should recognise that it is much better for the stock to take rather more than they need than that they should suffer from a shortage.

When the phosphate is fed direct, it is well to have some idea of the amount required per head. This varies with the class of stock, and to some extent with the kind of phosphate used.

Taking sterile bonemeal as the standard, the amount required per head per day will vary from about one ounce per day for a young calf (that is no longer receiving milk) to five ounces for a cow giving three gallons of milk a day, and an exceptionally heavy milker might require even more.

As Nauru phosphate contains approximately 50 per cent. more phosphoric acid than bonemeal, a correspondingly smaller amount may be given.

## SUMMARY.

Where phosphoric acid is deficient in the soil the herbage will also be deficient, this lack causing many stock troubles.

Lime cannot take the place of phosphoric acid, and it is not advisable to give lime in licks, as it lowers the digestibility of the phosphate.

Stock do not require as much common salt as is often thought necessary, therefore, particularly where the drinking water is saline, the amount of salt given should be small.

Nauru rock phosphate, which can be obtained from the superphosphate companies as ground rock phosphate, is quite suitable for stock, and is moreover the cheapest form in which to purchase phosphate for the purpose.

Iodine, sulphur, Epsom salts, and sulphate of iron may very occasionally be necessary, but should only be given in individual cases where found to be needed.

# FLAG SMUT RESISTANCE TESTS, 1928.

## MERREDIN EXPERIMENTAL FARM.

by

E. J. LIMBOURN, Seedsman.

These experiments were commenced because it was realised that Flag Smut (Urocystis tritici) is carried over in the soil, and attacks the young wheat plant during the very early stages of its growth, and there is no known treatment that will prevent infection of the seedling from the soil.

The original tests, carried out by Mr. W. M. Carne, Plant Pathologist and Botanist, in his laboratory at the Department of Agriculture, proved that infection could be obtained by dusting the grain with minced infected straw from diseased plants. This provided a definite means of obtaining information regarding the resistance of certain varieties to the disease, and in 1926, it was decided to commence a field experiment, on the same lines as that used for some years with Bunt or Stinking Smut (Tilletia levis.)

Field observations had already pointed to the high resistance of the variety "Nabawa," and also to the extreme susceptibility of the variety "Gluyas Early." For this reason "Gluyas Early" was used as the control, and it has since proved to be the most susceptible of any variety yet tested.

The results of these Field Tests during 1926 and 1927 were published in Journals of Agriculture for March, 1927 and September, 1928.

The experiment this year was divided into three sections:—

1. Varietal Resistance Test. A comparison of the resistance of a number of different varieties of wheat.
2. A test of the variation in resistance of Lines (or strains) of certain standard varieties grown by the Department of Agriculture as Seed Wheat.
3. A routine test of the resistance of new crossbred varieties at different stages in the selection of fixed types.

The method of infecting the seed was the same as in previous years, excepting that all surplus infecting material was sieved off. As was pointed out in the September Journal, this is done to overcome any possibility of the infection being carried to adjoining paddocks, by wind, when planting the seed.

That the lighter infection of the seed in no way affected the final results is shown by comparing the percentage infection of "Gluyas Early" for the three years. For 1926 the average infection was 35 per cent., for 1927, it was 49 per cent. and this year 45 per cent.

The seed was planted in rows ¼ chain long in two links apart, 50 seeds to each row.

Germination throughout was very good, averaging about 95 per cent. During the months of July and August, weed growth was out of control, and a few plants were probably destroyed when cleaning out the rows. In spite of this, well over 90 per cent. of the plants lived through until September, when the first inspection was made. All diseased plants were then pulled up, and after being counted, were destroyed. A further and final inspection was made during October to ensure that all diseased plants had been noted. The remaining clean plants were then counted.

## VARIETAL RESISTANCE OF WHEAT VARIETIES.

It was intended in this section, to include all varieties previously tested that had shown less than 20 per cent. infection, as well as new varieties not previously tested.

With the large number of Crossbred types to be planted, it was found that the space left was very limited, and only forty varieties, including a number of Crossbred types from the Chapman Farm section with controls could be included. Therefore only the better known or such varieties as had proved immune were planted.

The results are as follow:—

### FLAG SMUT RESISTANCE TEST, 1928.

TABLE I.—Varieties arranged according to comparative percentage of Control variety.

*Gluyas Early* = 100% *infection.*

| No infection found. | 1 to 20% infection. | 21 to 50% infection. | 51% and over. |
|---|---|---|---|
| % | % | % | % |
| P 421—Bunyip ... 0 | P1507—Clarendon 4 | P1429—Golden King 31 | P1697—Ranee 60 |
| P1438—Dindiloa ... 0 | P 223—Florence ... 4 | P1756—Wardfir ... 33 | P1792—Joffre ... 89 |
| P1739—Exquisite ... 0 | P1194—Queen Fan 4 | P1463—Patriot ... 38 | |
| P 915—Ford ... 0 | P1511—Genoa ... 9 | P 955—Newman's Early 42 | |
| P1800—Nolba ... 0 | P1721—Lilydale ... 9 | P 914—Caliph ... 44 | |
| P1445—S.H.J. ... 0 | P1710—Rajah ... 9 | P1749—(Federation Nabawa) 44 | |
| P1182—Wandilla ... 0 | P1786—Riverina ... 9 | P1038—Gresley ... 46 | |
| | P 920—Tobys Tusk 13 | | |
| | P1696—Confederation 15 | | |
| | P1750—Inderet ... 15 | | |
| | P 228—Comeback 20 | | |
| | P1713—Ghurka ... 20 | | |

TABLE II.—Crossbred varieties from the Chapman Experiment Farm not included in Line Resistance Test.

*Gluyas Early* = 100% *infection.*

| No infection found. | 1 to 20% infection. | 21 to 50% infection. | 50% and over. |
|---|---|---|---|
| % | % | % | |
| C59—(Nabawa x Bunyip) 0 | C61—(Federation x Bunyip) 4 | C83—(D.A.C. 4179 x Nabawa) 33 | |
| C65—(Huguenot x Indian 5) 0 | C70—(Federation x Bunyip) 4 | C67—(Toby's Tusk x Nabawa) 44 | |
| C77—(Florence x Carrabin) 0 | C56—(Currawa x Cowra) 9 | | |
| C80—(Dindiloa x Nabawa) 0 | (Nabawa x Gluyas Early) 20 | | |
| C81—(Florence x Nabawa) 0 | | | |
| C86—(Quality x Velvet Don) 0 | | | |

The infection of the Control Rows of Gluyas Early P159 varied from 26% to 66%. The average infection per row was 45% and this figure has been used to obtain the above comparative results.

Comparing the results for the three years that the experiment has been conducted, there are now six varieties:—Bunyip, Exquisite, Geeralying, Nabawa, Nolba and Wandilla, that have proved immune each year of the test.

Of these, Bunyip, has already been discarded from general use on account of weak straw.

Exquisite and Wandilla are Eastern State varieties that do not mature normally under our short season conditions.

Nolba, formerly M.19, is a cross between "Nabawa" and "Sunset" and does not yield too well under field conditions.

Nabawa is too well known to need any description. It is probably due to the universal growth of this variety that Western Australia owes its low percentage of loss from Flag Smut.

Geeralying is a variety that is being widely grown in the Geraldton district, but it is not so well known in the drier Eastern districts, where "Gluyas Early" because of its drought resistance is so deservedly popular. No variety of equal productivity has yet been found to supplant it, which is desired because of its great susceptibility to "Flag Smut." The results now available and particularly those with the almost fixed cross breeds point to the probability of replacing this variety with one having equal ability to yield well, but with greater resistance or immunity to the disease.

That to plant such susceptible varieties as "Gluyas Early," "Canberra," etc., is a danger to the wheat grower will be readily conceded when it is considered that large areas of these varieties are cut for hay which is distributed throughout the country as Chaff. As the name Flag Smut implies it is the flag or foliage and also the stems of the plant that show evidence of the disease, and carry the spores. Naturally, when cutting hay, any such diseased plant is included in the sheaves, and afterwards finds its way into the chaff cut from such hay.

Hereunder will be found the results of the tests with named varieties during the past three years-

TABLE III.—FLAG SMUT RESISTANCE TESTS.

A COMPARISON OF THE PERCENTAGES OF INFECTIONS WITH NAMED VARIETIES SINCE THE COMMONCEMENT OF THE EXPERIMENT.

*Gluyas Early—Infection* = 100%.

| Reg. No. | Variety. | 1926. | 1927. | 1928. | Reg. No. | Variety. | 1926. | 1972. | 1928. |
|---|---|---|---|---|---|---|---|---|---|
| | | % | % | % | | | % | % | % |
| 1700 | Alliance ... ... | ... | 52 | ... | 1921 | Lilydale ... ... | ... | ... | 9 |
| 1785 | Aussie ... ... ... | ... | 52 | ... | 1708 | Mahratta ... ... | ... | 47 | ... |
| 1271 | Bald Early ... ... | 15 | ... | ... | 1270 | Major ... ... ... | 5 | ... | ... |
| 1349 | Baroota Wonder ... | 5 | ... | ... | 1709 | Marmora ... ... | ... | 76 | ... |
| 859 | Baroota Wonder Early | 0 | 0 | 1 | 1440 | Merredin ... ... | 105 | 58 | ... |
| 1614 | Bena ... ... ... | 64 | ... | ... | 892 | Minister ... ... | 14 | ... | ... |
| 1789 | Binya ... ... ... | ... | 63 | ... | 1746 | Minyip ... ... ... | ... | 31 | ... |
| 1726 | Bobin ... ... ... | ... | 24 | ... | 1703 | Mogul ... ... ... | 74 | ... | ... |
| 1727 | Boolaroo ... ... | ... | 21 | ... | 1432 | Nabawa ... ... | 0 | 0 | 0 |
| 1736 | Boonoo ... ... | ... | 7 | ... | 1705 | Nabob ... ... ... | ... | 49 | ... |
| 1775 | Bredbo ... ... ... | ... | 19 | ... | 955 | Newman's Early ... | 12 | 5 | 42 |
| 1790 | Bruce ... ... ... | ... | 71 | ... | 1277 | Niloc ... ... ... | 36 | ... | ... |
| 421 | Bunyip ... ... ... | 0 | 0 | 0 | 1635 | Nizam ... ... ... | 14 | ... | ... |
| 1728 | Cadia ... ... ... | ... | 108 | ... | 1800 | Nolba ... ... ... | 0 | 0 | 0 |
| 914 | Caliph ... ... ... | 0 | 6 | 44 | 1769 | Noongaar ... ... | 28 | 6 | 27 |
| 709 | Canberra ... ... | 52 | 95 | ... | 1609 | Nugget ... ... ... | ... | 69 | ... |
| 1729 | Canimbla ... ... | 0 | 21 | ... | 1435 | Nungarin ... ... | 36 | ... | ... |
| 1698 | Capitol ... ... ... | ... | 85 | ... | 1741 | Omrah ... ... ... | ... | 59 | ... |
| 1788 | Cargo ... ... ... | ... | 43 | ... | 1701 | Parsee ... ... ... | 77 | ... | ... |
| 1447 | Carrabin ... ... | ... | 1 | 4 | 1463 | Patriot ... ... ... | ... | ... | 38 |
| 1507 | Clarendon ... ... | 3 | 7 | 4 | 1194 | Queen Fan ... ... | 0 | 0 | 4 |
| 228 | Comeback. ... ... | 3 | 0 | 20 | 1710 | Rajah ... ... ... | 2 | 4 | 9 |
| 1696 | Confederation ... ... | 3 | 0 | 15 | 1697 | Ranee ... ... ... | 17 | 12 | 60 |
| 1438 | Dinditoa ... ... | ... | ... | 0 | 1786 | Riverina ... ... | ... | 4 | 9 |
| 1776 | Dollar ... ... ... | ... | 9 | ... | 1190 | Roseworthy ... ... | 9 | ... | ... |
| 1744 | Dookee Delta ... ... | ... | 12 | ... | 1695 | Sepoy ... ... ... | ... | 7 | ... |
| 1774 | Duri ... ... ... | ... | 17 | ... | 1445 | S.H.J. ... ... ... | 0 | 6 | 0 |
| 1773 | Early Bird ... ... | ... | 32 | ... | 1704 | Sovereign ... ... | ... | 7 | ... |
| 1702 | Empire ... ... ... | ... | 96 | ... | 1712 | Sterling ... ... | 83 | ... | ... |
| 1739 | Exquisite ... ... | 0 | 0 | 0 | 1199 | Sultan ... ... ... | 7 | ... | ... |
| 460 | Federation ... ... | 18 | 47 | ... | 1699 | Suola ... ... ... | ... | 37 | ... |
| 223 | Florence ... ... | 0 | 0 | 4 | 920 | Tob'ys Tusk ... ... | 3 | 16 | 13 |
| 915 | Ford ... ... ... | ... | ... | 0 | 257 | Turvey ... ... ... | 9 | ... | ... |
| 1196 | Fortune ... ... | 16 | ... | ... | 1777 | Union ... ... ... | ... | 85 | ... |
| 1636 | Gallipoli ... ... | 9 | 21 | ... | 1711 | Viceroy ... ... | 29 | ... | ... |
| 1442 | Geeralying ... ... | 0 | 0 | 0 | 1182 | Wandilla ... ... | 0 | 0 | 0 |
| 1511 | Genoa ... ... ... | ... | 0 | 9 | 1637 | Wannon ... ... | 26 | ... | ... |
| 1713 | Ghurka ... ... | 11 | 9 | 20 | 1627 | Waratah ... ... | 74 | ... | ... |
| 1787 | Gluclub (Smith & Sou) | ... | 20 | ... | 1756 | Wardfir ... ... | ... | | 23 |
| 1754 | Gluclub (Victoria) ... | ... | 22 | ... | 226 | Yandilla King ... | 0 | 0 | 20 |
| 1337 | Gluyas Late ... ... | 29 | ... | ... | | | | | |
| 1429 | Golden King ... ... | ... | 17 | 31 | | | | | |
| 1038 | Gresley ... ... ... | 6 | 11 | 46 | | | | | |
| 1365 | Hard Federation ... | 26 | ... | ... | | | | | |
| 1750 | Inderet ... ... | ... | 0 | 15 | | | | | |
| 1792 | Joffre ... ... ... | ... | 7 | 89 | | | | | |
| 1706 | Krithia ... ... | ... | 12 | ... | | | | | |

The extreme variation in such varieties as Caliph-Newman's Early, etc. points to an unfixed factor of resistance to Flag Smut. Reference to the Line Resistance Test with Noongaar and Yandilla King, goes to prove this, as it will be seen that similar wide variation occurs between the resistance of the lines or strains under test.

## VARIATION IN THE RESISTANCE OF LINES (OR STRAINS) OF STANDARD VARIETIES.

This section of the experiment was commenced in 1927, and that year included both susceptible and resistant varieties. The results, as given in the September Journal, pointed to the improbability of obtaining resistant strains of either Gluyas Early, Canberra or Merredin.

It was therefore decided to discard these and to concentrate on improving or at least maintaining, by selection, the resistance of the more resistant varieties and any new varieties that may be added. For this reason tests with Nabawa, Carrabin and Noongaar were continued and Baroota Wonder Early, Geeralying and Yandilla King were added. The latter three are being tested as part of the work in connection with the production of pedigree seed of these varieties at the Chapman Experimental Farm, and seed for the test was obtained from that farm.

The results are given hereunder:—

FLAG SMUT RESISTANCE TEST, 1928.

TABLE IV.—Result of Line Resistance Test with Standard Pure Line Varieties.

Results given are Percentage of infection found.

| Line and Family. | Baroota Wonder Early. P859. | Carrabin. P1437. | Geeraly-ing. P1442. | Nabawa. P1432. | Noongaar. P1769. | Yandilla King. P226. | Line. |
|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | | |
| Ia. ... ... ... | 0 | 0 | 0 | 0 | 41 | 26 | a |
| II.a ... ... | 0 | 2 | 0 | 0 | 18 | 1 | b |
| III.a ... ... | 0 | 0 | 0 | 0 | 22 | 32 | c |
| I.b ... ... | 0 | 0 | 0 | 0 | 39 | 18 | d |
| II.b ... ... | 2 | 2 | 0 | 0 | 37 | 26 | e |
| III.b ... ... | 0 | 0 | 0 | 0 | 37 | 7 | f |
| I.c ... ... ... | 0 | 0 | 0 | | 28 | 15 | g |
| II.c ... ... | 2 | 0 | 0 | 0 | 9 | 27 | h |
| III.c ... ... | 5 | 0 | 0 | 0 | 18 | 12 | i |
| I.d ... ... | 0 | 0 | 0 | 0 | 31 | 22 | j |
| II.d ... ... | 2 | 2 | 0 | 0 | 24 | | |
| III.d ... ... | 2 | 0 | 0 | 0 | 31 | | |
| I.e ... ... ... | 0 | 0 | 0 | 0 | 18 | | |
| II.e ... ... | 0 | 0 | 0 | 0 | 24 | | |
| III.e ... ... | 5 | 0 | 0 | 0 | 28 | | |
| Average percentage of infection per line | 1 | 0·4 | immune | immune | 27 | 20 | |
| Variation in percentage infection per line | From 0% to 5% | From 0% to 2% | immune | immune | From 9% to 41% | From 7% to 32% | |
| Average percentage infection per family of 5 lines | Family I. 0% Family II.1% Family III. 2% | Family I. 0% Family II. 1% Family III. 0% | immune | immune | Family I. 31% Family II. 22% Family II. 27% | | |

These results exemplify the advantage of the method of selection carried out by the Department of Agriculture. It will be noticed that not only lines, but families of lines are detailed. By this means it is possible to select or reject a complete family of five lines, and selection is made from the three most resistant lines of the family having the lowest average infection.

## "LINE" RESISTANCE TEST WITH NEW CROSSBRED VARIETIES.

This section includes both fixed un-named varieties and types that are still showing variation in type.

In this report it is only proposed to deal with such as are fixed in type, and undergoing definite trials under paddock conditions.

Previous tests have shown the possibility of obtaining resistant types by Cross-breeding, and having a number of types with one or both parents of a resistant variety, considerable time has been saved that would have otherwise been needed to obtain such types. As a matter of interest the results are given hereunder.

FLAG SMUT RESISTANCE, 1928.

TABLE V.—RESULT OF LINE RESISTANCE TEST WITH FIXED TYPES OF CROSSBREDS HAVING "NABAWA" AS EITHER PARENT.

Results given are Percentages of infection found.

| Line. | Nabawa x Bunyip M14. | Nabawa x Gluyas E. M20. | Nabawa x Carrabin M26. | Nabawa x Carrabin M27. | Dindilos x Nabawa M28. | Dindilos x Nabawa M30. | Gluyas E. x Nabawa M31. | Florence x Nabawa M33 | D.A.C. 4179 x Nabawa C84. |
|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % |
| 1 ... ... | 0 | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 11 |
| 2 ... ... | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 8 |
| 3 ... ... | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 32 |
| 4 ... ... | 0 | 10 | 0 | 0 | 0 | 2 | 2 | 2 | 8 |
| 5 ... ... | 2 | 8 | 0 | 0 | 0 | 2 | 4 | 2 | 7 |
| 6 ... ... | ... | ... | 0 | 0 | 0 | 2 | 4 | 0 | 13 |
| 7 ... ... | ... | ... | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 8 ... ... | ... | ... | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 9 ... ... | ... | ... | 0 | 0 | 0 | 0 | 7 | 0 | 9 |
| 10 ... ... | ... | ... | 0 | 0 | 0 | 0 | 2 | 0 | 9 |
| 11 ... ... | ... | ... | 0 | 0 | 0 | 0 | 9 | 0 | 7 |
| 12 ... ... | ... | ... | 0 | 0 | 0 | 0 | 0 | 2 | 6 |
| 13 ... ... | ... | ... | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 14 ... ... | ... | ... | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 15 ... ... | ... | ... | 0 | 0 | 0 | 0 | 2 | 0 | 9 |
| Average percentage of infection per line | ·4% | 7% | im-mune | im-mune | im-mune | 0·5% | 2% | 0·5% | 9% |
| Variation in percentage of infection per line | From 0% to 2% | Fr m 2% to 10% | im-mune | im-mune | im-mune | From 0% to 2% | From 0% to 9% | From 0% to 2% | From 0% to 32% |

FLAG SMUT RESISTANCE TEST, 1928.

TABLE VI.—RESULT OF LINE RESISTANCE TEST WITH FIXED TYPES OF CROSSBREDS NOT HAVING "NABAWA" AS EITHER PARENT.

Results given are percentage of infection found.

| Line. | D.A.C. 4179 x Quality C74. | Fortune x Gluyas E. C79. | Comeback x Florence M11. | Federation x Bunyip M18. | Florence x Carrabin M24. | Florence x Fortune M32. |
|---|---|---|---|---|---|---|
| | % | % | % | % | % | % |
| 1 ... ... ... | 10 | 0 | 5 | 20 | 0 | 27 |
| 2 ... ... ... | 6 | 4 | 0 | 11 | 0 | 9 |
| 3 ... ... ... | 9 | 2 | 4 | 17 | 0 | 23 |
| 4 ... ... ... | 2 | 2 | 2 | 27 | 0 | 20 |
| 5 ... ... ... | 2 | 2 | 0 | 8 | 0 | 14 |
| 6 ... ... ... | 9 | 2 | 4 | ... | 4 | 23 |
| 7 ... ... ... | 2 | 2 | 2 | ... | 0 | 40 |
| 8 ... ... ... | 4 | 4 | 2 | ... | 2 | 11 |
| 9 ... ... ... | 10 | 0 | 6 | ... | 2 | 10 |
| 10 ... ... ... | 7 | 0 | 4 | ... | 0 | 18 |
| 11 ... ... ... | 4 | 0 | 0 | ... | 0 | 30 |
| 12 ... ... ... | 12 | 0 | 0 | ... | 2 | 22 |
| 13 ... ... ... | 2 | 0 | 2 | ... | 0 | 13 |
| 14 ... ... ... | 6 | 0 | 0 | ... | 0 | 23 |
| 15 ... ... ... | 7 | ... | 4 | ... | 0 | 29 |
| Average percentage of infection per line | 6% | 1% | 2% | 17% | 0·7% | 21% |
| Variation in percentage of infection per line | From 2% to 12% | From 0% to 4% | From 0% to 6% | From 8% to 27% | From0%to to 4% | From 9% to 40% |

# PASTURE DEVELOPMENT IN THE GREAT SOUTHERN AREA.

J. T. Armstrong, B.Sc. (Agr.),
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One who has not seen the districts south of Katanning for a few years cannot but be struck with the great development which has taken place in this area, especially in some of the Cranbrook country which, until comparatively lately, was regarded by many as being absolutely useless. Now some of the finest clovers which the writer has seen are in this area and on country which looks too hungry and poor to grow any crop.

The improvement is not only noticeable in the fields but also in the spirits and hopes of the farmers. They are all enthusiastic about pasture development and are perfectly certain that they can produce economically all the feed which they require for their sheep, and that the long lean periods are a thing of the past. A fine spirit of optimism is noticeable throughout this area.

The writer had intended, whilst on his tour of crop judging for the local Agricultural Societies' crop competitions, to speak of the advantages of establishing pastures, but he had no need, and often indeed no opportunity, to mention it to many—they were all so anxious to tell him of what they had done on their farms and what their neighbours had done.

The great secret of success of pasture development is top-dressing and the subsequent growth of clovers of various varieties, chief of which is Subterranean Clover.

The general method adopted to establish a pasture is to seed 1lb. of clean Subterranean seed with an Oat crop. This is reserved for hay, and so the clover is given an opportunity to seed down. In the following autumn, it is top-dressed with from 80 to 180 lbs. super. per acre, and in nearly every instance a fine pasture is established.

Some paddocks are seeded on the surface with clean seed and top-dressed, and, provided the plants are given a chance to seed down the first year, a good pasture is assured in the second year. The winning crop in the Cranbrook Agricultural Society's Fodder Crop Competition was seeded down on top of an old pasture. Almost any class of country seems to carry good clover crops if the plants are given a chance to seed down the first year or two and are top-dressed. The poor gritty white gum country and the treeless plain country are all going down under clover. Some farmers are top-dressing and seeding on the burn after slashing the scrub, or even without burning where the scrub is very sparse, and so developing pastures with the lowest initial cost.

Apart from Subterranean, the main clovers grown are Drooping Flower, Cluster, Hop, Yellow Suckling clover, the common burr Trefoil, and some fine crops of Crimson clover were seen, notably at Mr. Hall's farm at Cranbrook and Mr. Egan's farm at Narlingup out from Kojonup. This clover makes a good hay crop standing tall and erect and so is easy to cut, does well on poor country, and will take a big part in developing and improving light and poor soils. Drooping Flower clover is a favourite, making good growth

and seeding down well, and it is greatly relished by sheep and cattle generally. Yellow Suckling and Hop clovers seem to grow anywhere in the district, and, provided they are top-dressed, give a splendid yield of green feed or meadow hay.

The treatment of pastures varies slightly on different farms. Some farmers top-dress with 90 lbs. super; others give up to 180 lbs. in the autumn; some give two dressings of 80 to 90 lbs.—one in autumn and the other in the spring. The practice of two dressings, in the writer's opinion, is beneficial especially where the crop is to be cut for hay. The first topdressing to be given with the first rains, and when the feed has started well the sheep can be run on it until August, when they are taken out; a second dressing of 80 to 90 lbs. super is then applied, and the paddock shut up till the hay is carted. This early spring dressing makes a wonderful difference. Crops entered in the Fodder Crop Competitions which were treated in this manner were from 6 to 8 inches higher than the plots that had missed the second dressing.

The growing of clover crops for meadow hay is taking the place of oaten hay crops. This year many acres of pasture will be cut for hay, and next year far more meadow hay will be conserved.

Many inquiries were received from this area with reference to mowers and hay rakes, and the time to cut hay and how to cure it. The question of making silage was also discussed, but the practice of making hay is preferable with leguminous crops. These make mushy silage, and much of the valuable protein changes form and becomes more indigestible.

A large stack of meadow hay on a farm is the best insurance there is against a lean period. A block can quickly be cut from the stack with a hay knife and carted out to sheep or cattle, and they will eat up every straw. The hay can be thrown down on the ground or preferably into feeders of netting wire or slats: through the openings the stock will pull out all the hay they require. There need be no more starving times for the sheep from when the first rains come until the new green feed hardens up, as there has been in the past. Ewes can be hand-fed cheaply at lambing time. This means a stronger, healthier lamb; the ewe being in good condition will milk well, and the lamb will develop more quickly than it would with a starved mother.

Another big factor is smaller farms. Where a farmer on bush feed needed 4 acres or more per sheep, he can carry two or more sheep per acre on well developed pasture. He, therefore, can do with a smaller acreage. Farms will need more sub-division. Big paddocks will not be necessary for economical working as when big machines were used. Smaller paddocks are more profitable for grazing than big ones; stock can be changed from one paddock to another more frequently, giving benefit to the stock and allowing the pasture an opportunity to grow.

The development has been very noticeable in the last few years, and it will be more noticeable in the future. We must all crawl before we can walk, and so with the farmers. They can only afford at first to seed down and top-dress a small acreage and increase this year by year until the whole farm is under good pasture. The progress is much more rapid once a fair acreage is under feed, since the returns from the farm are much greater and more money is therefore available for further developmental work.

The development at present is almost wholly in the establishment of clovers, but some farmers are paying attention to getting in useful grasses. Along the railway Wimmera Rye grass is doing well on some farms and its use will spread. The big bulk of clover grown will considerably increase the nitrate content of the soil, and this will aid in the establishment of grasses. The decomposing vegetation and the sheep droppings will add greatly to the humus content of the soil, thereby improving its physical properties and increasing the water-holding capacity; consequently the crops will not dry off so quickly.

West of the Great Southern towards the area of heavier rainfall, Italian and Wimmera Rye grass should do well, and in the damper botoms Paspalum makes a stand. White Dutch clover and Lotus Major were seen in these damper areas, and this mixture—Paspalum, White Dutch and Lotus Major make wonderful pastures, holding out during the summer ready to grow with any summer showers and the early winter rains. East of the line where spring comes earlier, the early variety of Subterranean clover and possibly Wimmera Rye grass should give good feeding.

The following are details of crops entered in the Kojonup and Cranbrook Agricultural Societies' Crop Competitions:—

FODDER CROP COMPETITION, KOJONUP.

Points allotted.

| —— | Yield. | Freedom from Weeds. | Evenness. | Clover Content. | Total. |
|---|---|---|---|---|---|
| V. Pailthorpe ... ... | 49 | 16 | 13 | 13 | 91 |
| Eulin Pastoral Company ... | 50 | 16 | 11 | 12 | 89 |
| W. Webb ... ... ... | 27 | 15 | 8 | 12 | 62 |
| J. Egan ... ... ... | 27 | 16 | 5 | 13 | 61 |

*V. Pailthorpe.*—Soil gritty loam. Subterranean clover sown 5 years previous under oat cover crop. Top-dressed twice per year for last three years with 90 lbs. super. each dressing. This spring received 40 lbs. sulpate of ammonia in addition. Approximate yield per acre, 18 tons 14 cwt. green.

*Eulin Pastoral Co.*—Soil heavy red gum country. Old pasture which had been neglected, top-dressed twice per year with super. Yield approximately 19 tons per acre, green.

*W. Webb.*—Soil heavy loam, red gum and white gum. Subterranean clover seed sown with rape and oats in 1921. Top-dressed yearly with 90 lbs. per acre. This year two dressings of 90 lbs. each. Yield approximately 10 tons green. This plot was uneven due to places having been missed with the spring top-dressing.

*J. Egan.*—This crop was sown in April, 1927, with Subterranean clover under cover crop of oats; a little Crimson clover sown with the Subter-

ranean. Top-dressed with 100 lbs. super. in autumn and again in spring 100 lbs. super. Approximate yield per acre 10 tons. Places had been missed with spring top-dressing, and this made the crop very uneven.

FODDER CROP COMPETITION, CRANBROOK.

Points allotted.

| —— | Yield. | Freedom from Weeds. | Evenness | Total. |
|---|---|---|---|---|
| D. Morgan ... ... ... | 50 | 16 | 12 | 78 |
| R. Lewis ... ... ... | 46 | 16 | 13 | 75 |
| T. Hall ... ... ... | 47 | 15 | 12 | 74 |
| W. Furness ... ... | 35 | 13 | 8 | 65 |
| W. Pope ... ... ... | 32 | 16 | 9 | 57 |
| Under two years old— | | | | |
| D. McClean ... ... | 50 | 14 | 9 | 73 |
| Under one year— | | | | |
| W. Furness ... ... | 50 | 10 | 8 | 68 |

*D. Morgan.*—White gum country, gritty sandy loam. Sown with burr on top of old pasture five years. Top-dressed yearly 60 lbs. super. per acre; this year 90 lbs. super in autumn, 120 lbs. in August. Fed off with sheep till first week in August. Yield 3 sq. yards, 18 lbs. A particularly nice heavy crop. Yield approximately 13 tons per acre green.

*R. Lewis.*—White gum country. Subterranean clover sown with oats at rate of 1 lb. seed per acre in 1925. Topdressed twice per year—90 lbs. super. each dressing. Yield approximately 12 tons per acre green. Soil stiff red clay.

*T. Hall.*—Seed sown with oat crop in May, 1926, just over ½ lb. Subterranean clover seed and 1 lb. mixed clovers per acre with 90 lbs. super. In 1927 top-dressed in autumn and spring with 90 lbs. super. each dressing. This year received 1 cwt. super in March, 90 lbs. in September. In August harrowed with harrows upside down twice and rolled. Yield per acre approximately 12 tons 14 cwt. per acre green.

*W. Furness.*—Timber red gum, white gum, little jarrah. Pasture down for four years. Top-dressed with super. Approximate yield per acre, 9 tons 14 cwt. green.

*Under two years established.*

*D. McClean.*—Country jarrah annd red gum, zamia palms and scrub. Sown with oats in 1927 as cover crop for Subterranean clover 2 lbs. per acre. Super. 1 cwt. In 1927 received 100 lbs. super. in autumn and again in spring. Soil light loamy, clay subsoil and only once ploughed. Yield per acre approximately 10 tons 16 cwt. green.

*Under twelve months established.*

*W. Furness.*—Timber red gum, white gum, jarrah. Soil fairly stiff, ploughed once. Subterranean clover seeded with oats, 1 lb. seed per acre. Yield per acre approximately 3 tons 12 cwt. green. This promises to be a good pasture next year.

# BEEKEEPING NOTES.

H. Willoughby-Lance,
Apiculturist.

## MOTHS AND FOUL BROOD.

The Greater and Lesser Wax Moths are often blamed for more than their share of destruction in bee hives. Owners of bees often say that moths are responsible for the loss of their bees, but in most cases it is due to inexperience or careless beekeeping. Even beekeepers of long standing make this mistake.

In the first place colonies must be kept strong with bees of a good pedigree. By this is not meant one body-box full of bees and one or two half empty supers on top. There must be plenty of bees on all combs in districts troubled with moth. As regards pedigree, most Italian strains are good battlers against the moth pest, some better than others. Secondly, a large number of home-made hives have not the correct spacing. In many cases the frames are too close to the bottom or sides of the hive. In others they are too close to the cover. In other words there is not what is called a bee space on all sides of the frame. The bees cannot get through and start filling the space with propolis. But the moth grub can and does get into these spaces and the bees, however eager they may be, cannot get at the grub.

In some cases beekeepers use mats of roofing felt, sacking or other material over the top of the frames, the bees cannot get between the mat and the frame, but the grub can and does. These mats are also a harbour and nesting place for ants. In one case recently out of 16 hives with mats on, 15 had ants' nests with thousands of eggs between the mat and the cover.

In normal cases strong colonies should have an entrance of ⅜in. deep by the full length of the hive, but if the colony becomes weak the entrance should be contracted by placing a strip of wood along the entrance, reducing this according to strength from the full entrance down to two inches. This will assist the bees to guard the entrance against the moths and robber bees.

If, however, the colony becomes very weak it should be united to another colony. Two weak ones united stand a chance of building up to one strong colony, but if left alone will probably succumb to moths or robber bees.

Do not leave hives more than twelve months without cleaning the floor boards; excessive accumulation of cuppings or refuse is a harbour for moth grubs. Once a year at least the floor boards and interior of the hives should be scraped and scrubbed with a solution of Izal; one part of Izal to 300 parts of water will be strong enough. Then leave to dry in the sun.

Always remember that prevention is better than cure.

Dealing with the connection of Moths with Foul Brood, some people think that there is no connection between the two, and in more cases than one I have found that moths have been blamed for destruction which has really been due to Foul Brood. The moths had only come in afterwards. In the meantime robber bees came along and cleaned up the honey, and carried the infection to other hives.

In one recent case the owner found a hive empty, except for moths. He told me that he had fumigated this with bisulphide of carbon, and put a swarm into it. On examination nearly all the combs were found to have either infected larvae or dried up spores of Foul Brood. On examination of other hives they were found to have Foul Brood in the early stages. Probably all of these had started from the one empty hive.

Moral—do not blame the moths for all empty hives. The colony may have got weak through a failing or poor queen. The hive may have been so constructed as to assist the moth and hinder the bees, or Foul Brood may have been the cause of the loss of the bees.

The last cause is a very insidious and dangerous one, as it may cause the spread of this very infectious disease due to mistaken diagnosis.

As Foul Brood has been found in various parts of the State, it behoves all beekeepers to endeavour to correctly ascertain the cause of weak or empty hives. Any empty hives, with or without moth, should be carefully examined for the spores of Foul Brood in the brood combs, and if any doubt exists, a sample piece of the comb should be sent to the Department of Agriculture.

## ELECTROCULTURE EXPERIMENT.

By I. THOMAS and J. H. LANGFIELD.

This is a continuation of the previous experiment conducted on the Merredin Experiment Farm.

On this occasion the apparati were transferred to another location and erected by a representative of the vendor. The land on which the experiment was conducted was Gimlet and Salmon running into Mallee. It was ploughed the second week in August to a depth of 4in., but received no further treatment until after rain in May, when it was disced twice with a Tandem disc. Planting took place on the 6th June. Seed 43 lbs. and super. 120 lbs. per acre. It was harrowed after the drill.

The results are appended:—

MERREDIN EXPERIMENT FARM.

*Electro Culture Experiment.*

Variety—Gluyas Early. Seed—43 bs. pe acre.
Superphosph te—120lbs. per acre. Date planted—5th June, 1928.

| | Computed Yield per Acre. | | | | | | | | Per-centage. |
|---|---|---|---|---|---|---|---|---|---|
| Plot ... | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | |
| | bus. lbs. | bus. lbs. | bus. lbs. | bus. lbs. | bus. lbs. | bus. lbs. | bus. lbs. | bus. lbs. | |
| Not connected with apparatus ... ... | 19 4 | ... | 19 28 | ... | 19 20 | ... | 19 28 | 19 20 | 100 |
| Connected to Electro-culture ... ... | ... | 19 12 | ... | 18 56 | ... | 19 28 | ... | 19 12 | 99·22 |

# COOLING CONTRIVANCES AND RECIPES.

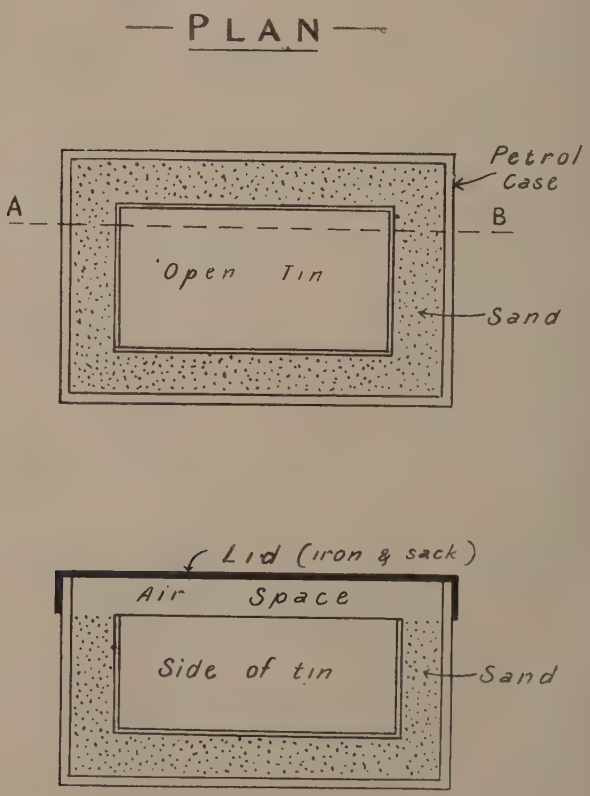
Margaret H. Reeves—Domestic Science Centre—Perth

The importance of thoroughly effective apparatus for cooling food in hot weather cannot be over-estimated. The food we enjoy is that which combines careful cooking, dainty serving, and proper nourishment with pleasing flavours and appearance. A half-set jelly—be the flavour and ingredients ever so good—fails to please. Greasy butter is the most unappetising food possible. What one does not relish, loses a percentage of value to the individual. The well-known ice chests produce good results, and are more economical if kept packed with ice covered with newspaper or an "ice blanket," which may be purchased for about 2s.

In districts where electric light is not installed and ice is not obtainable, our good friend the "Coolgardie Safe" comes to our aid, and with a small supply of water and a little care, is very effective. Pieces of hessian hanging over the sides allow for a better flow of water than flannel.

A cheap cooler may be contrived thus:—

1. Cut the side from a petrol tin. Turn in cut edge and hammer smooth.



2. Lay a petrol case on its side with open top towards you. Remove the side that now forms the top using two of these boards to close front to within an inch or two of the top.
3. Pack bottom of prepared case with thoroughly wet sand.
4. Place petrol tin in the case and fill in spaces between tin and box with sand, well wet and pressed down tightly.
5. Food is placed in tin and the whole covered with a clean wet cloth.
6. Make lid with a flat sheet of iron a little larger than top of box. Bend tin downwards by hammering at sides and ends to keep it in position.
7. Cover with wet sack.
8. Keep in airy place preferably near a tap.

*Butter Coolers.*

(*a.*) Place a brick in an old pie dish or tin containing a little water. Set butter on brick and cover with wet hessian large enough for ends to hang in the dish of water.

(*b.*) Stand vessel containing butter in a dish of water. Thoroughly wet a new flower pot and invert it over the butter so that it rests in the dish of water.

A butter box sunk in damp ground and covered with a wet sack forms quite a good cooler.

*Gelatine Puddings.*

*Gelatine.*—Very thin sheet gelatine or powdered gelatine should be used for following recipes. Half oz. of sheet gelatine is equal to three teaspoons of powdered gelatine.

*Blanc Mange.*

½ oz. gelatine, 1 pt. new milk, lemon rind, 1 tablespoon sugar.

*Method :*

1. Soften gelatine in a little of the cold milk.
2. Place remainder of milk with sugar and a piece of yellow lemon rind in white lined saucepan. Make hot.
3. Add gelatine. Do not boil. Remove from fire. When gelatine is dissolved remove lemon rind.
4. Pour into wet mould. Put in a cool place until set firm.
5. Serve in a glass dish with stewed fruit

*Apple Jelly.*

1lb. apples
1 lemon.
3 ozs. sugar.
½ oz. gelatine.
1 cup water.
colouring.

*Method :*

1. Dissolve gelatine in half the water.
2. Boil remainder with sugar, 1 teaspoon lemon juice and slice of yellow rind. Add prepared apples. Cook until tender. Rub through sieve.
3. Stir in gelatine. Mix well.
4. Turn half into wet mould. Colour remainder and pour on top.
5. When set, turn out and serve with cream.

*Lemon Sponge.*

½ oz. gelatine.
½ pint water.
2 lemons.
3 ozs. loaf sugar.
2 eggs (whites only).

*Method :*

1. Soak gelatine in water half an hour.
2. Put into saucepan with yellow rind of 1 lemon and sugar. Heat until gelatine dissolves.
3. Add lemon juice. Strain.
4. Leave to cool.
5. Gradually stir in well-beaten whites of egg. Beat until cold and thick.
6. Turn into wet mould.
7. When set, turn into glass dish. Serve with whipped cream—and half pint of custard made with the two yolks of egg.

*Orange Jelly.*

2 oranges, 2 ozs. loaf sugar, ½ lemon, ½ oz. gelatine.
½ cup water, white and shell of 1 egg.
1 inch cinnamon stick.

*Method :*

1. Soak gelatine in water ½ hour.
2. Peel off yellow rind of fruit and rub in sugar to extract oil.
3. Squeeze juice from fruit into lined saucepan. Add gelatine, water, sugar, rind, partly beaten white of egg and shell. (There should be ½ pint fruit juice.)
4. Whisk over fire until boiling. Take out whisk and simmer until clear.
5. Dip cloth in boiling water. Strain jelly through twice.
6. Turn into wet mould to set.
7. Serve with cream.

*Siberian Cream.*

½ pt. milk, ½ tablespoon sugar, 2 eggs.
¼ oz. gelatine, 3 drops vanilla or lemon essence.

*Method :*

1. Soak gelatine in milk ½ an hour. Bring nearly to boil. Add sugar.
2. Beat yolks of eggs well and gradually pour hot milk over it. Stir well.
3. Return to saucepan. Stir over fire until custard thickens. Cool.
4. Stir in beaten whites of egg to which has been added 1 dessertspoon sugar. Beat well.
5. Turn into wet mould to set.
6. Serve in glass dish with cream.

*Note*.—When doubling the quantity, three eggs are sufficient.

# Have you tried this Delightful Custard?

With

Serve them separately or together—
or with Cooked or Fresh Fruits,
Fruit Pies or Preserves.

# METEOROLOGICAL INFORMATION.

| STATIONS. | TEMPERATURE. | | | | RAINFALL. | | TEMPERATURE. | | | | RAINFALL. | | TEMPERATURE. | | | | RAINFALL. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | | Minimum. | | For Month. | Average. | Maximum. | | Minimum. | | For Month. | Average. | Maximum. | | Minimum | | For Month. | Average. |
| | Mean. | Highest. | Mean. | Lowest. | | | Mean. | Highest. | Mean. | Lowest. | | | Mean. | Highest. | Mean. | Lowest. | | |
| | SEPTEMBER, 1928. | | | | | | OCTOBER, 1928. | | | | | | NOVEMBER, 1928. | | | | | |
| | | | | | inches. | inches. | | | | | inches. | inches. | | | | | inches. | inches. |
| Chapman Farm ... State ... | 68·7 | 79·0 | 47·5 | 38·5 | 1·39 | 1·69 | 72·4 | 86·7 | 48·8 | 40·3 | ·85 | ·99 | 85·8 | 103·4 | 55·9 | 48·1 | ·04 | ·27 |
| Geraldton ... ... | 69·5 | 77·0 | 50·8 | 44·0 | ·91 | 1·40 | 70·6 | 80·4 | 54·1 | 41·2 | ·50 | ·72 | 77·7 | 100·4 | 59·0 | 50·2 | ·02 | ·26 |
| Walebing ... ... | 65·9 | 76·3 | 43·9 | 37·1 | 2·60 | 2·30 | 69·6 | 85·2 | 45·1 | 37·4 | 1·40 | 1·35 | 84·5 | 99·0 | 53·2 | 39·0 | ·33 | ·54 |
| Perth ... ... | 64·8 | 73·0 | 51·9 | 44·1 | 5·04 | 3·42 | 66·7 | 74·8 | 49·9 | 41·6 | 1·78 | 2·22 | 76·5 | 99·0 | 56·8 | 48·8 | ·41 | ·80 |
| Kalamunda ... ... | 65·8 | 72·0 | 48·5 | 41·0 | 6·39 | 4·69 | 66·6 | 80·4 | 47·5 | 38·2 | 1·84 | 3·31 | 77·5 | 97·0 | 54·4 | 44·0 | ·51 | 1·08 |
| Bunbury ... ... | 63·4 | 70·2 | 50·3 | 36·2 | 5·02 | 3·73 | 65·4 | 77·2 | 48·6 | 38·2 | 2·51 | 2·46 | 74·8 | 89·5 | 53·3 | 47·2 | ·52 | 1·03 |
| Bridgetown ... ... | 62·6 | 73·0 | 44·9 | 29·8 | 6·18 | 3·94 | 65·8 | 76·0 | 44·1 | 35·0 | 2·81 | 3·07 | 79·0 | 94·2 | 48·8 | 37·2 | ·46 | 1·14 |
| Albany ... ... | 62·1 | 69·4 | 48·1 | 41·4 | 6·21 | 4·11 | 62·3 | 72·4 | 49·5 | 42·0 | 3·35 | 3·27 | 68·0 | 85·4 | 54·1 | 46·4 | ·72 | 1·34 |
| Merredin Farm State | 67·5 | 81·0 | 43·7 | 31·8 | ·71 | 1·00 | 71·8 | 84·6 | 45·0 | 29·8 | ·19 | 0·84 | 86·8 | 100·5 | 55·0 | 42·0 | *Nil* | ·38 |
| Northam ... ... | 67·0 | 75·2 | 45·7 | 36·0 | 1·58 | 1·64 | 70·7 | 84·0 | 44·7 | 35·0 | ·61 | 1·00 | 85·0 | 101·0 | 53·9 | 42·1 | ·07 | ·40 |
| York ... ... | 66·9 | 74·0 | 45·4 | 34·0 | 1·60 | 1·64 | 70·3 | 83·2 | 44·3 | 34·0 | ·39 | 1·05 | 84·3 | 100·0 | 53·1 | 40·2 | ·10 | ·44 |
| Narrogin Farm State | 62·6 | 69·2 | 43·1 | 30·5 | 2·28 | 2·33 | 66·0 | 78·8 | 42·0 | 29·8 | ·76 | 1·51 | 80·6 | 96·6 | 49·3 | 41·3 | 06 | ·57 |
| Katanning ... ... | 62·5 | 69·6 | 44·5 | 32·0 | 2·85 | 1·96 | 65·5 | 77·1 | 44·5 | 34·7 | 1·06 | 1·61 | 79·6 | 96·0 | 50·5 | 42·3 | ·16 | ·63 |
| Cape Leeuwin ... | 60·4 | 64·5 | 53·2 | 48·0 | 4·16 | 3·42 | 62·3 | 69·0 | 53·6 | 46·0 | 2·89 | 2·95 | 67·1 | 83·2 | 56·6 | 47·2 | ·58 | 1·24 |

## MARKET REPORT.

Messrs. H. J. Wigmore and Company Limited, of 613-619 Wellington street, Perth, have supplied us with the following information regarding chaff available at the Metropolitan chaff and grain auction sales held in Perth, for the period, September to November (inclusive). In all cases the prices quoted are for f.a.q. to prime wheaten chaff, packed in new bags.

September—

Quantity—1,500 tons.
Minimum price—£6 15s.
Maximum price—£5 15s. per ton.

October—

Quantity—1,200 tons.
Minimum price—£6 10s.
Maximum price—£5 15s. per ton.

November—

Quantity—1,100 tons.
Minimum price—£6 15s.
Maximum price—£5 7s. 6d. per ton.

New season's chaff was late putting in an appearance this season and was not available until early in November. Consignments arriving at that date were scarce and the market firmed to £6 15s. per ton, receding as supplies became available, the following being closing quotation:—

F.a.q. to prime—£5 10s. per ton.
F.a.q.—£5 2s. 6d. to £5 5s. per ton.
Mediums—£4 12s. 6d. to £4 15s. per ton.

Oaten chaff:- Right throughout the period under review there has been a good demand for oaten at prices equivalent to wheaten, in fact at times it has been possible to secure more for prime samples of oaten.

Oats:—Very few consignments were available up to the end of October and good heavy feeds were selling at around 4s. 6d. per bushel. However, early in November, under weight of new season's coming to hand, the market eased. Prices, however, are still satisfactory, there being some demand for good clean heavy Algerians or Guyras at from 3s. to 3s. 3d. per bushel, light feeds being difficult to quit at lower prices.

Wheat:—The local market has fluctuated somewhat, there being a steady demand at around 4s. 10d. per bushel.

# PRODUCERS' MARKET REPORT.

Producers' Markets, Ltd., report as under for Quarter ended 30th November, 1928:—

*Fruit.*

Supplies of Fruit increased for the period and values were satisfactory. Apples ex Cool Store were short and values firm. Valencia Oranges have been plentiful and good lines sold at satisfactory values, although values for medium and inferior lines were somewhat uncertain. Local Tomatoes increased in volume, and values throughout have been firm. Passion Fruit still continues short and high values obtained for any quality fruit. Lemons of prime quality showed a big improvement and with weather conditions favourable values should continue. Stone Fruits are now coming forward and the demand for good coloured fruit is good.

*Vegetables.*

Supplies of vegetables have been heavy for the period. At the commencement of the quarter Potatoes were short in supply and values were high. Very few country samples of any quality were coming through our rooms. We handled a good crop from the Wokalup District and these met with good competition, realising top values. Metropolitan crops are being dug and the sample is prime. Most crops are from the Certified Seed Scheme and all growers report good crops and satisfactory yields. We are submitting some picked samples and buyers are operating freely on these. The demand is easing now and when exporting ceases values will ease again. Brown Onions are coming forward in large quantities and values have settled down to 10s. to 12s. cwt. for prime Globes. White Onions are selling well, particularly good quality Silver Skins and Globes. Cabbage supplies have been heavy and the demand very weak. Any lines below prime are hard to quit at any price. Pumpkin shortened quickly during the period and values firmed to as high as 33s. cwt. New season's Turk's Cap is on the market now and the position will not be so acute. Cauliflowers were well supplied and some prime samples were offered. Values were high and the late crops were very satisfactory to the growers. Metropolitan Swedes were in steady supply and values were firm all along. Country lines were mostly of poor quality and the demand for these was very weak. Rhubarb supplies were plentiful and the demand good. Rhubarb growers were fortunate that apples were so short when their crop was so heavy. Values have eased with the marketing of soft fruits and are likely to be easy while supplies of peaches and apricots are plentiful. Cucumbers were forwarded in fair quantities and values were good. Marrows are in fair supply also and values good on account of the Pumpkin shortage. Bunch Roots were heavily supplied and the demand has eased with the coming of warm weather. Beetroot is in demand. Turnips are unsaleable. Lettuce is in good demand and prime lines are firm. Inferior sorts easy.

### *Eggs.*

The supply during the past three months has been very heavy and, although W.A. exported 111,885 doz. eggs during this period, the supply on the local market was more than equal to the demand. The production which has held remarkably well is showing a falling off during the past few weeks. Local values at present are ranging from 1s. 4½d. to 1s. 7d. per dozen for specially graded eggs.

### *Poultry.*

Heavy supplies of all lines, except Turkeys, have been coming forward and, although the quality has been very medium, the prices have remained high. Turkeys appear to be very short this year and as much as 60s. per pair is being paid for prime quality. Drakes showing quality are eagerly sought after and have realised as much as 20s. and 22s. per pair.

## LIVE STOCK AND MEAT.

For the information of readers of the "Journal," the following particulars have been supplied by Messrs. Elder, Smith & Co., Limited, Perth:—

COMPARATIVE YARDINGS OF STOCK YARDED AT METROPOLITAN FAT STOCK MARKETS FOR SEPTEMBER, OCTOBER, AND NOVEMBER, 1928.

| — | SEPTEMBER, 1928. | | | | OCTOBER, 1928. | | | | | NOVEMBER, 1928. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5. | 12. | 19. | 26. | 3. | 9. | 17. | 24. | 31. | 7. | 14. | 21. | 28. |
| Sheep & Lambs | 8,635 | 11,942 | 8,230 | 8,801 | 12,891 | 14,524 | 15,543 | 15,292 | 13,232 | 14,396 | 19,791 | 12,126 | 18,792 |
| Cattle ... | 838 | 638 | 813 | 610 | 493 | 618 | 630 | 619 | 634 | 711 | 889 | 709 | 879 |
| Pigs .. | 542 | 597 | 481 | 909 | 612 | 419 | 708 | 746 | 640 | 569 | 543 | 388 | 424 |

COMPARATIVE VALUES PER LB. OF STOCK SOLD AT METROPOLITAN FAT STOCK MARKETS DURING SEPTEMBER, OCTOBER, AND NOVEMBER, 1928.

| — | SEPTEMBER, 1928. | | | | OCTOBER, 1928. | | | | | NOVEMBER, 1928. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5. | 12. | 19. | 26. | 3. | 9. | 17. | 24. | 31. | 7. | 14. | 21. | 28. |
| Mutton | 9½ | 10 | 10 | 11 | 7½* / 11† | 6* / 9½† | 6* | 6 | 6 | 6 | 6½ | 7 | 6½ |
| Beef ... | 6½ | 7¼ | 8 | 8½ | 9¼ | 8¾ | 7½ | 8 | 8½ | 8 | 8½ | 8 | 7¼ |
| Pork ... | 13 | 13½ | 13½ | 13½ | 13½ | 13½ | 13 | 12½ | 11½ | 11 | 10½ | 10½ | 10½ |
| Bacon | 10 | 10½ | 10½ | 11 | 11 | 11 | 11 | 10½ | 9½ | 9½ | 9 | 9½ | 9½ |

* Shorn. † Woolly.

WESTERN AUSTRALIA—DEPARTMENT OF AGRICULTURE.

## List of Bulletins available for Distribution.

No. 30.—*Codlin Moth.* L. J. Newman. Free.
No. 74.—*Tobacco Growing: Notes for Intending Planters.* By G. W. Wickens. Free.
No. 79.—*Sheep on the Wheat Farm and their Management in W.A.* By H. McCallum. Free.
No. 83.—*Horticulture and Viticulture.* By A. Despeissis. Price 2s.
No. 87.—*Sheep Feeding Experiments: State Farm, Chapman,* 1920. By G. L. Sutton and F. Vanzetti. Free.
No. 88.—*Light Land: Conference.* By G. L. Sutton. Free.
No. 90.—*Stock Waters: Standard for Composition of.* By E. A. Mann. Free.
No. 93.—*The Home Tanning of Sheep and other Skins.* By H. Salt. Free.
No. 94.—*The Dingo.* By B. W. Leake. Free.
No. 96.—*Poison Plants of W.A.* By D. A. Herbert. Free.
No. 99.—*Australian White.* By G. L. Sutton. Free.
No. 101.—*Cotton Cultivation.* By G. L. Sutton. Free.
No. 103.—*Kerosene Method for Eradicating the Zamia Palm.* By G. K. Baron-Hay. Free.
No. 105.—*Pedigree Selection of Seed.* By G. L. Sutton. Free.
No. 106.—*The Red Legged Velvet Earth Mite.* By L. J. Newman. Free.
No. 109.—*Rape.* By G. L. Sutton. Free.
No. 112.—*Automatic Device for Eradication of Stickfast Flea.* By G. Allman. Free.
No. 113.—*Picked Pieces (Classification of Clip).* Free.
No. 114.—*Blue Mould on Citrus Fruits.* By W. M. Carne. Free.
No. 115.—*The Value of Windmills for Pumping Water in W.A.* A. H. Scott.
No. 116.—*Spotted Wilt of Tomatoes.* W. M. Carne.
No. 117.—*Cream.* P. G. Hampshire.
No. 118.—*Pigs and Pig Raising.* P. G. Hampshire.
No. 119.—*Take-all of Wheat and Similar Diseases o Cereals.* By W. M. Carne and J G. C. Campbell.
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